

Responsible Lighting Guidelines for Kaikoura

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*Milky Way over the South Pacific Ocean with light pollution (skyglow) from Kaikoura on the right, and Christchurch on the horizon in the distance.
Image Paul Wilson. <https://astrodaddy.co>*

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Please note that the next version of this document will also include responsible lighting guidance for marine vessels, cycling and eco tours, interior lighting for retail spaces, hospitals, retirement homes, spas and retreats.

Disclaimer

The opinions expressed in this document are the author's, based on peer-reviewed research and professional lighting guidance documents.

Introduction to the Kaikōura Dark Sky Trust Project - Responsible Lighting Guidelines

The purpose of this document is to outline how responsible lighting can be achieved for both interior and exterior situations. It's been produced to help the reader understand what can be accomplished, whether modifying existing lighting or starting a new project. The guidelines go above and beyond the minimum requirements often found in local council district plans, and they show how to achieve the best outcomes for reducing light pollution and how to attain all the associated benefits.

The document is structured to provide a general overview with some guiding fundamentals and principles. It is then broken into handy sections to help the reader to find the best practice lighting guidance relevant to their specific needs. It shouldn't be relied upon on its own but read in conjunction with other relevant lighting requirements.

There are no downsides to responsible lighting and the benefits are so broad-reaching and widespread it's a wise and prudent approach for towns and cities that value sustainability. Not only do best lighting practices provide better conditions for safety, security, health, and quality of life, it also saves money, reduces energy consumption, and lowers carbon emissions and maintenance/operation costs, and there is far less impact on wildlife, ecology and the environment.

Thank you for taking the time to read this document which has been carefully produced by the Kaikōura Dark Sky Trust. We would be very happy to assist with any queries you may have regarding content of the document. We can be contacted at kaikouradarksky@gmail.com

The Kaikōura Dark Sky Trust formed the dark sky initiative with the aim of becoming an International Dark Sky Reserve. This will ensure long lasting protection of our night skies and demonstrate to the Kaikōura community and beyond, the benefits and beauty of clever, creative, well executed lighting. It is important to understand becoming a Dark Sky Reserve is not about "being in the dark", it is about the responsible management of artificial light at night and the mitigation of light pollution. We hope you are inspired by what we wish to create for the wider Kaikōura District.

Our Vision

"To encourage the protection, enhancement, and preservation of the exceptional Dark Skies of the Kaikōura District."

Our Strategic Statement

To achieve and maintain International Dark Sky Reserve status for the Kaikōura District through accreditation with the International Dark Sky Association. We aim to reduce light pollution by managing artificial light at night (ALAN) in our natural and built environments, including the lighting of urban streets, rural roads, residences, businesses, public venues and spaces. The outcome will produce long-term social and health benefits, an enhanced economy, and better protection of the Takiwa of Kaikōura, its environment and ecological systems.

The Future

Responsible lighting plays a key role in helping New Zealand attain the enviable opportunity of becoming a dark sky nation, boosting our country's reputation around the globe as a "must visit" destination. Feel free to reach out to us if you have any questions or would like to get involved with our initiative. You can find more information on our website about light pollution and how to reduce its effects, as well as how to enjoy our wonderful night sky. kaikouradarksky.nz We hope you will embrace the best intentions of this guide as we move to preserve the dark skies in the unique Kaikōura environment that we call home. *On behalf of our Kaikōura Dark Sky Trust, Nicky McArthur, Chair.*

Acknowledgements

We would like to acknowledge, credit and thank the following people, groups, organisations and businesses for their support and help in providing content, images, feedback and information contained in this document. [Australasian Dark Skies Alliance \(ADSA\)](#), [Flagstaff Dark Skies Coalition](#), [International Dark Skies Association \(IDA\)](#), [Lightaware Charity](#), [Leibniz Institute of Freshwater Ecology and Inland Fisheries](#), [Lightwise Guild](#), [McDonald Observatory](#), [Mont-Mégantic International Dark Sky Reserve](#), [Slowlight Spain](#), [Softlights Organisation](#), Alejandro Sanchez De Miguel, Andrew Hatfield, Annabella Rijksen, Annette Krop-Benesch, Avalon Owens, Anna Levin, Brad Phipps, Bill Softky, Bill Wren, Brian Healey, Bridgette Farnworth, Buddy Steffanoff, Colin Henshaw, Collette Doughty, Chris Kyba, Christian Luginbulh, Daan Rossegaarde, Deborah Moran, Derek Ambrosio, Diana Umpierre, Ellen Cieraad, Frederik Waneck Borello, Gary Hart, Grainne Bunting, Grant Moodie, Hamish Scott, Johannes Fischer, John Hearnshaw, Joyce Harmen, Karolina Zielinska-Dabkowska, Kellie Pendoley, Kerem Ali Asfuroglu, Larry Field, Linnea Tillet, Lorna Deppe, Mark Baker, Marty Lockett, Michelle Bannister, Michelle Greenwood, Mike Geddis, Nathan Wilson-Rynell, Nisa Khan, Paul Marchant, Paul Le Comte, Paul Wilson, Peter Barnett, Rangi Matamua, Reagan Stuart, Remi Boucher, Richard Somerville Ryan, Sabine Frank, Sabrina Luecht, Simon Nicholas, Spencer Millsap, Stephen Hummel, Steve Butler, Steve Brian, Steven Hummel, Sybille Schroer, Ted Howard, Theresa Jones, Tom Harradine, Wayne Renner, [Acuity Brands](#), [Acrospire](#), [Advanced Lighting Technologies \(ADLT\)](#), [AEC Illuminazione](#), [Arch Daily](#), [Arch Images](#), [ATP Lighting](#), [Block Blue Light](#), [Cree Lighting](#), [Crossroads LEDs](#), [CLS Lights](#), [Dan Pal Light Architecture Solutions](#), [Delta Light](#), [DW Windsor Lighting](#), [Edeko](#), [Elemental LED](#), [Energylight Christchurch](#), [Erco Lighting](#), [EWO Lighting](#), [First Light Technologies](#), [Form and Light](#), [FPOV](#), [Gemma Lighting](#), [Herzog De Meuron](#), [Hondel Lighting](#), [Ignia Lighting](#), [iGuzzini Lighting](#), [Illumania](#), [Inui](#), [Lakelites](#), [Lanai Lights](#), [LEDs Magazine](#), [LEDlinear Lighting](#), [Light Bureau](#), [Ligman Lighting](#), [Linnaea Tillet Lighting](#), [Lorax Design Group](#), [Louis Poulson](#), [Lucian Light](#), [Majestic Outdoor Lighting](#), [Maryland Lighting](#), [Metcalf Lighting](#), [Musco Lighting](#), [Neri Lighting](#), [Nevana Designs](#), [Outdoor Lights](#), [Philips](#), [RD Light Le Mouret](#), [Schreder Lighting](#), [Signify](#), [Simmons Signs](#), [SLA Designers](#), [Studio Roosegaarde](#), [Superior Light](#), [Taico Brands](#), [Targetti Lighting](#), [Truelight Distribution](#), [True Lumens](#), [WE-EF Lighting](#), [Wraight + Associates \(WAAL\)](#). Thank you Nicky McArthur for the introduction, the [IDA](#) for inspiring the infographics on pg 12 and 14, and [Flagstaff Dark Sky Coalition](#) for inspiring the infographic on pg 2 and 3.

The Immense Value and Importance of Preserving Natural Darkness

“Like the ecological fragility we are witnessing in the natural world, darkness stands as something to be preserved and restored with intention – both technically and culturally. In doing so, we are called to think (and design) beyond human centrality, acknowledging planetary needs as well as our own.” Maya Shpiro

As the use of artificial lighting is rapidly increasing, we need to understand why darkness must be protected and preserved. A philosophical, and especially moral investigation into the disappearance of darkness should be seen as a pragmatic endeavor.² This is important because a better understanding of darkness today, will provide an important step towards establishing the conditions for morally desirable nighttime lighting infrastructure; it will help to establish how we should light our twenty first century nightscapes.

The International Dark Sky Association (IDA), the world’s leading authority on light pollution defines light pollution simply as “any adverse effect of artificial light”.

The Critical Role of Nocturnal Placemaking

Public lighting must be reimagined so it’s both functional and safe, has less impact on human biology and ecological systems and allows for visibility of the stars again.³ Sustainability depends upon healthy biodiversity especially in the built environment, so it’s crucial to implement **nocturnal placemaking**. This involves deliberately keeping designated areas free from artificial light or having very low, subtle, well-controlled levels of illumination to create ecological safe havens and sanctuaries.

Our default should be to respect and protect darkness, and when we do introduce light to apply and use it in a thoughtful, restrained and carefully executed manner.

The infographic below illustrates what to avoid and what to aim for with lighting.



With the global increase in the use of LED lighting and the fact this technology in particular has many unwanted adverse effects that is worse than previous forms of lighting, it’s imperative we move away from lighting where vehicular (street lighting) takes priority - to a more sustainable, safer and healthier approach. One where protecting the health of humans, wildlife, ecosystems, and the environment, and access to the nocturnal land and sky scape are prioritised instead.

“The introduction of bright, white LED light fixtures has made it simple and cheap to flood the world with more light than is needed – wasting energy and money at the same time.” Ruskin Hartley Executive Director of the IDA.

Key For Symbols in Document

For simplicity, examples of lighting are categorised as **AVOID**, **IMPROVED** and **OPTIMAL**. There are more examples in the AVOID category as there are so many instances of poorly executed lighting. IMPROVED lighting shows the effectiveness of BETTER and BEST (as shown in the above infographic). There are even less examples in the category OPTIMAL because more awareness and education are needed about well-executed lighting and the crucial role of nocturnal placemaking. For extra clarity, a red cross in a red circle indicates lighting that should be avoided at all costs (AVOID). Whereas, the amber dash in an amber circle indicates IMPROVED lighting. Please keep in mind that IMPROVED lighting involves the application of dimming, curfews, timers and sensors. The green tick in a green circle shows the OPTIMAL approach. In some infographics there’s also a symbol of a white clock for the use of curfews, timers/sensors to control lighting so it’s off during off-peak hours and activated by sensors, so it turns off again once the space is unoccupied.



1 - Beyond Illumination: Reflections on the Impacts of Lighting Design <https://henninglarsen.com/en/news/archive/2021/12/21-responsible-lighting>
 2 - The Value of Darkness: A Moral Framework for Urban Nighttime Lighting. June 2017. <https://link.springer.com/article/10.1007/s11948-017-9924-0>
 3 - The Ecological Cost of Artificial Light. Australian Science. July/August 2019. <https://www.australianscience.com.au/article/issue-julyaugust-2019/ecological-cost-artificial-light.html>

Responsible Lighting Guiding Principles

- 1 - All lights have a clear, specific purpose (task specific).
- 2 - Use fully-shielded, full cut-off light sources. Ensure LEDs have recessed diodes/chips.
- 3 - Use LEDs with optical diffusers and hidden/covered diodes for safety and visual comfort.
- 4 - Choose warm, amber lighting (1600-2200 K) as shown circled in green on the right.
- 5 - Position and angle light sources carefully and direct light only to where it's needed.
- 6 - Control lighting via dimming, curfews, sensors and/or timers.
- 7 - **Less is more.** Use low lumen output LEDs and low lighting levels to reduce contrast.
- 8 - Aim for **quality lighting** - warm, softly dispersed, evenly distributed, indirect light to improve visibility, safety and comfort.
- 9 - Use vertical lighting to assist visibility and orientation. (See pg 4 and 13.) Avoid horizontal lighting. (See pg 13.)
- 10 - Use lighting only when required and switch off when not in use.
- 11 - Avoid light clutter. (See pg 13.) A few well-designed lights are better than numerous glary, poorly designed luminaires.
- 12 - As soon as it gets dark, close curtains and louvres, and cover skylights to prevent interior light escaping outside.
- 13 - Prioritise **nocturnal placemaking** whenever possible and practical. (Explained on pg 2.)



***The International Dark Skies Association (IDA) updated their guidance in early 2021. "To minimise negative environmental impacts, IDA recommends using lamps rated at 2200K CCT. Phosphor-Converted Amber LED, or some filtered LED.⁴**

(If using white light sources (2700-3000 K) choose low lumens, lower the intensity via dimming, and apply automatic sensors and/or timers.)

Additionally -

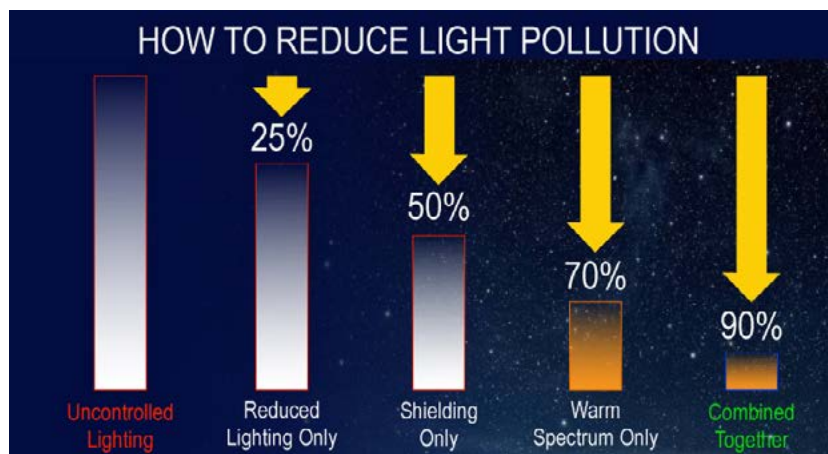
- Any lighting for roads, public walkways and cycle paths should be managed to improve visibility, visual comfort and safety, minimise sky glow, and avoid light shining on areas of water.
- In ecologically sensitive areas, non-residential lighting is best avoided between 11 pm to 5 am in summer and 10 pm to 6 am in winter.
- Self-illuminated signs (with an internal light source) should be avoided. Instead, downlight a matt surface with a dark background for signage.
- Skylights in buildings (especially in residential homes) are acceptable if they have adequate louvres/blinds.

Ideally, for savings in energy, maintenance, and operation costs, human health and well-being, and to protect ecology, the environment and the nightscape, we should aim to minimise our use of light, and when we do illuminate an area, it should be with appropriate, effective and fit-for-purpose light sources that provide **quality light**.

Quality light is warm in colour (1600-2200 K) with an appropriate spectrum (zero to minimal blue wavelengths of light). It is indirect, softly dispersed and evenly distributed so it assists visibility and is pleasant to be around. The lighting level (amount of light) is low (low contrast) and comfortable. Such lighting is also well-controlled and directed to avoid light spill/trespass/nuisance.

Benefits of Responsible Lighting

- Saves energy and supports sustainability.
- Improves visibility, safety, comfort and life quality, and assists in orientation, navigation and wayfinding.
- Supports human health and is less disruptive to nocturnal species, ecology, and the environment.
- Protects the night sky from light pollution and supports astrotourism and stargazing which can boost the local economy.
- Enhances the appearance, ambience and curb appeal of buildings, properties, homes and neighbourhoods.



The above infographic was inspired by Flagstaff Dark Skies Coalition www.flagstaffdarksdies.org. The above percentages are based on research.⁵

4 - <https://www.darksdies.org/our-work/lighting/values-centered-outdoor-lighting/>

5 - [The relation of outdoor lighting characteristics to sky glow from distant cities. Sept 2014. Lighting Res. Technol. 2014; Vol 46: 35-49](#)

Lighting Fundamentals

“Energy efficiency concerns may have driven the changes to lighting technology over recent years, but we need to ensure that future lighting is fit-for-purpose without unintended detriment to people and the environment.” John O’Hagan, UK Health Security Agency⁶

Light pollution is the presence of unwanted, inappropriate, excessive, misdirected, inefficient and unnecessary artificial lighting and it can be caused by any poorly implemented lighting, both during the day or night. Light pollution is increasing at a rapid rate and contrary to what the lighting industry claims, LED lighting technology is worsening the situation.⁷ Recent research estimates the transition to solid-state light-emitting diode (LED) technology may have increased radiance (brightness) of light globally by 270% and 400% in specific regions.⁸

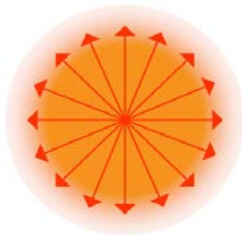
LED lighting proliferated from 2006 onwards, when this technology was removed from within the scope of IEC60825 - the international standard used for assessing photobiological risks from laser and LED light sources (ie. the risk of retinal and/or thermal damage to the skin). Until 2006, LEDs were restricted under the laser standard because LEDs are an extremely intense, concentrated light source. However, once the protection provided by IEC60825 was removed, instead of creating a third LED-specific standard, LEDs were placed under the risk assessment standard for general lighting: IEC62471. The lighting industry then promoted LED technology almost exclusively on the basis of its energy efficiency - and the various serious drawbacks were downplayed and even ignored.

The Difference Between a Spherical Light Emitter and a Flat Surface Light Emitter (LED)

LED lighting technology is unlike other forms of conventional lighting that have been used before, and due to its unique properties, existing lighting metrics and standards cannot be applied. (Unfortunately, this has not been well understood by the lighting industry and contractors.) Cree Lighting released a white paper, April 2022, which admits this. It’s the first time the lighting industry has acknowledged the issue.⁹ Cree says, “Not one of the existing metrics takes into account the non-uniform emitting surface of a LED luminaire.”

Light sources such as the sun, candles, incandescent, and gas-discharge lamps, like the older orange high-pressure sodium (HPS) street lights, are spherical emitters which emit light evenly in all directions (uniform or isotropic). However, LEDs are flat surface emitters that produce intensely concentrated, light in a highly directional way (non-uniform or anisotropic).¹⁰ This is why LEDs without adequate diffusing optics are dangerously

Spherical Light Emitter vs Surface Light Emitter



bright, no matter the colour of light they emit. Spherical light emitters project light in all directions uniformly, whereas LEDs don’t. Their light is narrowly concentrated and intensely bright and travels in a forward direction. By incorrectly claiming LEDs are point sources, the Illuminating Engineering Society (IES) enabled utility and lighting companies to continue using the same standards, protocols, testing devices, and health research that applied to uniform light sources. Standards such as the IES RP-8-18 need to be updated to include safety standards for LEDs for peak luminance, peak radiance, spectral power distribution, flicker, flutter and flash rates, etc, etc. The photometric software that engineers use must also be updated.

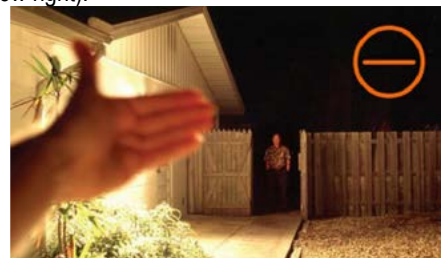
CCT is an Inadequate Metric. The unique properties of LED technology also mean the metric Correlated Colour Temperature (CCT) measured in Kelvin (K) is inadequate and cannot be applied for accurate results. (CCT only indicates the apparent warmth or coolness of a light as perceived by the human eye.) It does not provide information about the spectral characteristics of LEDs such as how much disruptive blue light it emits. For this, it’s necessary to use spectral power distribution (SPD). Until the lighting industry provides an improved metric, be aware that CCT is inadequate.

Human Vision. Current codes and design practices do not adequately consider the way the human eye perceives brightness.¹¹ **The quality of light is far more important than the amount.** Vision at night performs best when lighting is at low levels, is warm in colour, softly dispersed, evenly distributed (low in contrast), and indirect (does not shine directly into the eyes). Such lighting enables safe navigation and the ability to detect objects in shadow. This is why it’s helpful for light to wash vertical surfaces such as walls (**vertical lighting**), to assist orientation, wayfinding and safety. Whereas horizontal lighting (below left) shines directly into the eyes, which hinders vision and compromises safety.

Brighter is NOT Better. Bright lighting does NOT increase safety. All it does is give a false sense of security, as seen (below left). In reality, vision at night is hindered by bright light sources, as the person standing at the gate is undetectable. However, when light sources are shielded so the diodes/bulbs are hidden from view, people/objects can be seen as shown (below right).



Compromised visibility due to unshielded, glary, high contrast lighting.



Improved visibility with indirect, glare-free lighting. Images George Fleenor.

6 - Lighting for health (good or bad). Nov 2018. <https://journals.sagepub.com/doi/10.1177/14771477153518810632>

7 - Artificially Lit Surface of Earth at Night Increasing in Radiance and Extent. Nov 2017. <https://www.science.org/doi/10.1126/sciadv.1701528>

8 - First Estimation of Global Trends in Nocturnal Power Emissions Reveals Acceleration of Light Pollution. July 2021. <https://www.mdpi.com/2072-4292/13/16/3311/html>

9 - Cree White Paper. Is Street Lighting Damaging Our Health? April 2022. <https://online.flipbook.com/view/702884488/18-19/>

10 - M. Nisa Khan. <https://www.researchgate.net/project/Why-Inorganic-LEDs-have-Inherent-Glare-and-Extremely-High-Luminance>

11 - Brighter Isn’t Safer. https://www.arup.com/perspectives/lighting-the-way-for-women-and-girls-a-new-narrative-for-lighting-design-in-cities#_YgQNaIaNLQI.linkedin

White LED Lighting is Inappropriate

Although well-directed, glare-free, white light can be helpful for tasks requiring detailed, close-up work like surgery, harsh, bright, white LED lighting is unsuited for street lighting and general exterior lighting. The spectrum and excess brightness (radiance) is unsafe, and the strong contrast also hinders vision, increasing visual disturbances, and reducing visual acuity. Drivers 40+ years, as well as those with the degenerative eye condition keratoconus (a common form of astigmatism) are particularly vulnerable to these adverse impacts. This lighting is also discriminatory to the elderly as the scattering effect of short blue wavelengths of light within the human eyeball worsens with age. This results in veiling glare and can make driving safely at night impossible. Furthermore, glare increases in poor weather (rain, mist, fog, snow) as the shorter blue wavelengths of light readily scatter in the air, reflecting off water molecules which worsen driving conditions. This scattering effect increases on wet or hazed wind-screens, through the glass itself, or the film that builds up on the inside. Additionally, when the road is wet, road markings are obscured. As blue light emits more energy than longer wavelengths, it also has the potential to do more harm, for instance, dazzle drivers, cyclists, and pedestrians, and cause long-term permanent degeneration to the human eye, etc.

Most importantly, the unnatural temporal and spatial properties of LEDs are incompatible with the human nervous system. LEDs are documented to cause epileptic seizures, migraines, unpleasant neurological symptoms, psychological trauma, and eye damage, and can also prevent people who are disabled by light (light disabled) from accessing public services, participating in society, and driving. Additionally, the disruptive blue-rich light from white LEDs can adversely impact those on anti-depressant medication and individuals on the autistic spectrum. **Furthermore, the intensely bright, blue-rich light emitted from white LEDs at night is an unnatural phenomenon and it's highly disruptive to the natural world.**

Legal Action

On December 13, 2021, approximately 52 customers (Petitioners) of Niagara Mohawk Power Corporation, d/b/a National Grid (National Grid), filed a petition, pursuant to Public Service Law (PSL) §71, requesting the removal of installed LED streetlighting in the village, to be replaced with non-LED streetlights and lowered to below 20 feet. The petitioners cite sleep disruption, visual distortion, glare and driving impairment, headaches, and seizures as reasons for the request. The petition mentions a resident who suffered hundreds of epileptic seizures after the installation of LED streetlighting. [CASE 21-02623 - Complaint of M and R Cherry and Others Concerning LED Street Lights in the Village of Cambridge.\(Issued March 29, 2022\)](#). Cases like these are likely to become more common as the ill-effects of LED lighting becomes more widely known.

Debunking Common Fallacies

Even with advances in technology and science, many common misconceptions persist about lighting. Some of them involve misleading, incorrect, and unfounded claims, outdated assumptions, as well as faulty and/or biased research which has led to scrutiny and valid criticism.^{12,13,14} The topic of lighting is complex and vast so not all of the misconceptions have been debunked here.

1 • Fallacy - White LED street lighting delivers improved quality lighting.

FACT - Typical white LED street lights (shown pg 8) do not deliver safe, appropriate, improved lighting. Firstly, these light sources emit high energy, blue wavelengths of light which scatter in the eyeball causing veiling or disability glare. This impedes vision and can force a person to instinctively look away from the light source.¹⁵ Glare reduces safety and is hazardous for drivers, cyclists, pedestrians and residents. Secondly, exposed LED diodes/chips emit light that's non-uniform and intensely bright (excess radiance) which can cause disability glare and visual discomfort. It's also shown to be detrimental to eye health.¹⁶ Although glare can be partially mitigated by dimming, the problem needs to be properly resolved. (Cree was the first lighting manufacturer to publically admit residents don't want to live next to harsh, glary LED street lights – and in response, developed a glare-free, warm white 2700 K luminaire, shown on pg 8).¹⁷ Although more manufacturers are now developing diffusing optics to reduce glare, even amber 1600-2200 K LED street lights require diffusing optics to be safe. **When unfit-for-purpose light sources have been installed, it's critical to significantly dim them to reduce excess radiance.**

False Economy. Thirdly, unlike other conventional light sources, LED lighting technology emits highly directional light (non-uniform or anisotropic). Swapping out light sources such as high-pressure sodium (HPS) that deliver uniform, evenly distributed light, using the same existing poles with LEDs that emit intensely bright, highly directional, non-uniform/anisotropic light, is one of the reasons for countless failed LED retrofits. Instead of improving lighting conditions, they are worsened with hot spots of high-intensity light contrasted with dense pools of darkness, and unacceptable light trespass into homes and properties. Furthermore, the spectral characteristics of white LEDs are unsafe and inappropriate for nighttime illumination. **As scientific evidence continues to mount about the inappropriateness of white LED lighting, advisory bodies are updating guidelines. This includes the IDA, which now recommends 2200 K and below.**¹⁸

FACT - White lighting from LEDs is unsafe and inappropriate for traffic, road, and street lighting.

The International Engineering Society (IES) admitted in their updated guidelines RP-8-18, Chapter 2 section 2.3.4.2 that they used the wrong spectral sensitivity curve to determine lighting for roadways and parking lots.¹⁹ Their advice for white light was based on the scotopic (dark adapted) curve when the eyes use only rods, and do not see colour. This curve peaks in the bluer white part of the spectrum and should never have been used. Instead, the IES should have used the curve for photopic (light adapted) vision because the eyes use cones, and see colour under exterior lighting. That curve peaks in the warm part of the spectrum (amber).

12 - Paper presented at the Transportation Group 2019 Conference, Te Papa, 3-6 March 2019. <https://az659834.vo.msecnd.net/events/sairaueprod/production-hardening-public/d560c9df614941e2bd35d8ff55bcbf9>

13 - Bad Science: Comments on the paper 'Quantifying the impact of road lighting on road safety - A New Zealand Study' by Jakkett & Frith (2013). Oct 2019. <https://www.researchgate.net/publication/340033678>

14 - Science can inform better lighting decisions. Nov 2016. <https://www.odt.co.nz/opinion/science-can-inform-better-lighting-decisions>

15 - Road Lighting for Safety. (London: Thomas Telford Publishing, 1998). p. 107. <https://www.amazon.com/Road-Lighting-Safety-Schreuder-Hardcover/dp/B011MF1REY>

16 - Light pollution: the possible consequences of excessive illumination on retina. Eye (Lond). 2016. 30(2): 255-263. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4763120/>

17 - Cree Lighting Inc, youtube channel. Accessed 1st May, 2022. <https://www.youtube.com/watch?v=7WgJ9uPvNH4>

18 - IDA updated guidance for Values-Centered Outdoor Lighting. <https://www.darksky.org/our-work/lighting/values-centered-outdoor-lighting/>

19 - <https://www.ies.org/standards/ies-standards-cross-reference/>

The IES also cautions against glare and over lighting in their standards because this reduces visibility, yet due to the properties of LED lighting (non-uniform light distribution and excess radiance) most LED street lights retrofits produce unacceptable glare, contrast, light trespass and nuisance (obtrusive lighting). Most importantly, this same standard, IES RP-8-18 Roadway and Parking Facility Lighting, applies to visible radiation that is uniform in all directions (isotropic). Yet, LED streetlights and parking lot lights are non-uniform (anisotropic) radiation sources, for which IES RP-8-18 is inapplicable. Physics determines the spatial light distribution of LEDs is different from other conventional light sources, unless LEDs spatial light distribution is “manipulated” in an attempt to mimic conventional sources (via the application of diffusing optics, lightpipe technology, etc). Very few LED products do this, so the non-uniform spatial light distribution causes unpleasant glare, “hot spots” of brightness, and problematic pools of darkness. The strong contrast of white LEDs also makes it difficult for eyes to adjust in time to darker areas, which also compromises visibility and safety.

2 • Fallacy - bright white lighting increases safety, reduces crime and lowers vehicle collisions.

FACT - Despite large scale studies conducted in scientifically respectable ways, no solid scientific evidence exists to back up these claims. Note crime is a societal problem, not a lighting problem.^{20,21} A comprehensive, robust study in the UK (costing approx NZD \$800,000) found no evidence that reduced street lighting at night increases road casualties or crime. Local authorities can safely reduce street lighting at night without increasing road casualties or crime.²² In contrast, the brightest areas such as city centres show some of the worst crime and disorder.²³ In fact, a recent 2020 study revealed that when lights went out in a certain part of a city, crime shifted to where the light remained on; crime followed the light.²⁴ While it may seem counterintuitive at first, extensive research says we do not know what happens to crime in darkness when lighting is increased or reduced.²⁵ However, we do know that criminals need light to do their mischief, e.g., identify targets and opportunities, and they are less obvious and blend in under well-lit areas (no need for a torch). What’s more, studies reveal increased lighting can be associated with an increase in criminal activity.^{26,27} In One recent study suggests switching off street lights between midnight and 6am may actually reduce some types of crime.²⁸ Studies which purport to show brighter lighting reduces crime have been shown to be flawed.^{29,30} **Bright lighting only provides a false sense of security.**

Additionally, there’s no substantial evidence of a link between brighter street lighting and nighttime vehicle collisions. In fact, it was found that brighter, whiter lighting may increase or decrease collisions by no more than a few percent in the most comprehensive study to date on the safety effects of lighting. This study showed a **statistically significant increase in collisions** in one UK region, after brighter lighting was installed. (Further research reveals introducing **brighter road lighting may compromise safety** rather than reduce harm, although more conservatively, a more secure interpretation is that again, we do not know what the lighting does to road collisions.)

3 • Fallacy - The human eye sees best at night with bright white light.

Fact - During starlight and moonlight conditions, the human eye uses rods to see which are highly sensitive. This sensitivity is achieved by dropping the ability to see colour in exchange for detail. Bright white light at night, overloads night vision and so the eyes no longer see the detail needed to be safe. Decreased vision reduces safety. Additionally, knowing what we do about the adverse harm of health disrupting white light at night on human health and ecology, introducing more of it into the environment is misguided, especially when safer, more appropriate options exist.

4 • Fallacy - White 4000 K LED street lighting is similar to moonlight.

Fact – This misleading claim falsely implies white LED street lighting is benign and akin to natural light. Although moonlight appears cool in colour, it cannot be compared to the light emitted by white LED street lights. For one, CCT is an inadequate metric and cannot be used to compare the spectral characteristics between the moon and artificial LED lighting. Also the spectral power distribution (SPD) which shows the various wavelengths of light emitted by a 4000 K LED is considerably different to the SPD of moonlight. The lux (brightness) from LED lights is also much more intense. (A full moon is between 0.03- 0.1 Lux whereas the brightness of an average street light is about 40 Lux.) Furthermore, the moon is not visible every night and it goes through many phases and positions in the sky. The light reflected from the moon travels hundreds of thousands of kms and is also diffused by the Earth’s atmosphere, whereas an LED streetlight is approx only 4.5 - 9.1 metres above the surface of the street with no diffusion at all. Wildlife behaviour has evolved with moonlight over millennia, whereas artificial white light at night is out of place and incompatible with a healthy nighttime environment for humans and ecology. It’s much safer to limit lighting to fully shielded, full cut-off, amber 1600-2200 K light sources (in the case of LEDs they require diffusing optics), with dimming and motion sensors.³¹ Also it’s important to know to keep in mind that recent research shows human sensitivity to light at night can vary greatly and the degree of sensitivity is much higher than previously thought.³²

5 • Fallacy LED street lighting is more energy efficient than older conventional forms of street lighting.

Fact - Contrary to what the lighting industry claims, high-pressure sodium lighting is energy efficient. It produces 80-150 lumens per watt, where as LEDs typically deliver between 90-120 lumens per watt. Most importantly, the definition of energy efficiency is for a product to provide the same or improved quality performance with less energy.^{33,34,35} However, although LED emit light, they do not deliver it in the same way, nor do they emit the same quality of light. They also cause adverse impacts and physical harm, unlike the HPS street lamps they replace. Spherical emitters and flat surface emitters are two very different products. LED lighting technology produces inferior quality of light with adverse effects.

20 - What Happens in the Shadows: Streetlights and How They Relate To Crime. 2017. <https://kinder.rice.edu/sites/default/files/documents/Kinder%20Streetslights%20and%20Crime%20report.pdf>

21 - Evidence regarding the impact of the street lighting on crime and antisocial behaviour. August 2015. https://cambridgeshireinsight.org.uk/wp-content/uploads/2017/08/Street-Lighting-Policy-Note_Final.pdf

22 - What is the effect of reduced street lighting on crime and road traffic injuries at night? A mixed-methods study. September 2015. <https://www.journalslibrary.nihr.ac.uk/phr/phr03110#abstract>

23 - Light Pollution Endangers Our Security and Our Safety. <https://cescos.fau.edu/observatory/lightpoll-security.html>

24 - Street Light Outages, Public Safety and Crime Displacement: Evidence from Chicago. Feb 2020. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3526467

25 - The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis. July 2015. <https://jech.bmj.com/content/69/11/1118>

26 - Ibid.

27 - <https://www.darksky.org/wp-content/uploads/2014/09/Chicago-Alley-Lighting-Project.pdf>

28 - Street lighting increases theft from cars, rather than deterring opportunists. March 2022. <https://phys.org/news/2022-03-part-night-halves-vehicle-crime-displace.html>

29 - Does changing to brighter road lighting improve road safety? <https://jech.bmj.com/content/74/5/467>

30 - Why Lighting Claims Might Well Be Wrong. July 2017. <https://lightingjournal.org/index.php/path/article/view/71/79>

31 - www.nachhaltig-beleuchten.de/blog/en/is-a-4000-kelvin-led-street-light-like-the-moon/

32 - High sensitivity and interindividual variability in the response of the human circadian system. June 2019. https://www.pnas.org/content/116/24/12019?ijkey=60de661f78b47bf3205c17b9a9f8e05ec258c657&keytype=tf_ipsecsha

33 - https://www.energystar.gov/about/about_energy_efficiency

34 - <https://www.lawinsider.com>

35 - United Kingdom Department of Energy and Climate Change. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/65598/6918-energy-efficiency-strategy-statistical-summary.pdf

The spatial, spectral and temporal characteristics of LED light are significantly different, which is why there are so many failed LED retrofits that have worsened lighting conditions, reduced safety, compromised health and wellbeing, comfort, and life quality, and increased light pollution. Also, the transition to LED lighting technology has NOT reduced energy consumption due to the rebound effect (Jevons' Paradox). Rather than reduce energy consumption, more light is being used than before, and areas that weren't previously lit are being illuminated. Ironically, saving energy was the main reason for adopting LEDs, and the unnecessary justification behind the banning and phasing out of much safer light sources.³⁶

6 - Fallacy - White LED street lighting at night improves safety and is better for driving.

Fact – There is NO substantial evidence this is the case. In fact, lighting expert Wout van Bommel explains why blue-rich white LEDs road lighting is unsuitable for road, traffic and pedestrian safety, (especially for NZ's aging population).³⁷ The high-intensity light emitted by white LEDs forces the pupil of the eye to constrict which hinders vision at night, making it inappropriate for street lighting. This is particularly problematic when passing through areas that are brightly lit, into areas with lower levels of lighting, as the eyes struggle to adjust in time. Furthermore, white LED street lights are discriminatory to the mature population and those who are light disabled. (As the eyes age they become more vulnerable to the veiling disability caused by blue wavelengths of light that scatter in the eyeball).³⁸ Coupled with less light entering the pupil, yellowing of the lens, the blinding glare of LEDs, and their excess radiance, this dangerous lighting has forced many people to give up driving and lose their independence.³⁹ (Additionally, LED head lights can be up to 400 x brighter than regular halogen vehicle lights, and now, due to daytime running LED headlights on modern vehicles, this problem is no longer limited to when it's dark at night.)

7 • Fallacy - Exposure to the light emitted by LED light sources such as street lights is not harmful.

FACT - All artificial light at night impacts biology. It is NOT benign. However, high intensity white LED lighting is phototoxic and can lead to irreversible damage to the eye, no matter if the light source is a mobile phone, computer screen, or a street light. In 2019, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) issued a damning report on the risks of over-bright LED lighting,⁴⁰ confirming the toxicity of blue light on the retina can lead to a decline in sight and increase the risk of age-related macular degeneration. The report also states even a very small exposure to blue-rich light at night, disrupts the body clock (circadian rhythm) and therefore, sleep. There are also concerns about the effects of changes in the circadian rhythm on the foetus in pregnancy. Furthermore, a high proportion of LED light sources have significant flicker, and children, adolescents and light sensitive people can be more vulnerable and suffer adverse effects.

ANSES advises reducing light pollution as much as possible to preserve the environment. Although the 2018 EU Sheer report acknowledged some individuals experience adverse health effects such as headaches and migraines from the flicker of LEDs, the report downplayed scientific studies stating, 'There is no evidence of direct adverse health effects from LEDs in normal use by the general healthy population'.⁴¹ This conclusion excluded infants, teenagers and the elderly who are vulnerable, and make up a significant part of society. It's unacceptable not to take their health and safety into account.⁴² The Sheer report also devalues other risks and most importantly, neglects to explain that excess radiance is harmful to all humans, no matter their age. It's also indisputable some people cannot tolerate the light emitted from LEDs. This includes those with autism, lupus, migraine, photophobia, and seborrheic eczema. Most troubling, some individuals with no previous light sensitivity find exposure to LEDs triggers symptoms that include confusion, dizziness, eye pain, fainting, headaches, insomnia, nausea and skin pain.⁴³ The number of people who experience adverse reactions is unknown because this information is not being collected.

8 • Fallacy - White LEDs reduce light pollution.

FACT – Research confirms white LEDs retrofits significantly increase light pollution.^{44,45} The transition to solid-state light-emitting diode (LED) technology may actually increase radiance in the visible spectrum by 400%. Even when LEDs are fully shielded and light is directed downwards, light pollution increases due to the scattering effect of shorter wavelengths of blue light. The light polluting impact of light sources can be gauged by the scotopic/photopic ratio (S/P ratio). **An LED retrofit should have a similar or improved S/P ratio of the lights that are being replaced.** However, 3000 K LEDs have a S/P ratio of (1.3), double that of the older HPS lamps (0.64).⁴⁶ Below left, unshielded, high-pressure sodium (HPS) lamps in Dunedin 2016, compared to shielded, white 3000 K LEDs in 2021, below centre. Below right, shows the increased sky glow caused by 3000 K LEDs installed in Dunedin (circled by a red outline).



Image Brad Phipps



Image Brad Phipps



Skyglow seen at Waikouaiti Beach, 50 kms away. Image Stefan Mutch.

36 - The Rebound Effect and the Jevons' Paradox: Beyond the Conventional Wisdom. September 2019. <https://www.frontiersin.org/articles/10.3389/fenrg.2019.00090/full>

37 - Ibid

38 - W. van Bommel. (2015) Age Effects. In: Road Lighting. Springer, Cham. <https://link.springer.com/book/10.1007/978-3-319-11466-8>.

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43 - <http://www.softlights.org/stories/>

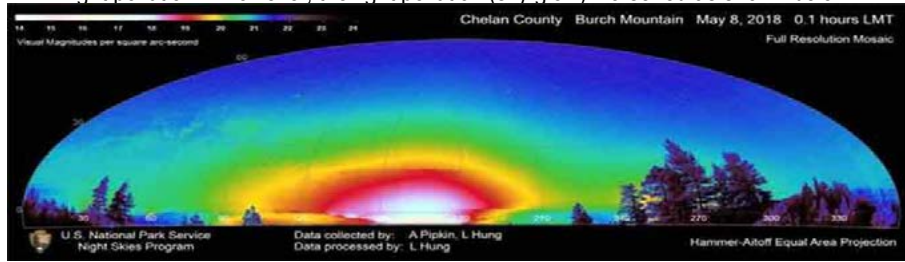
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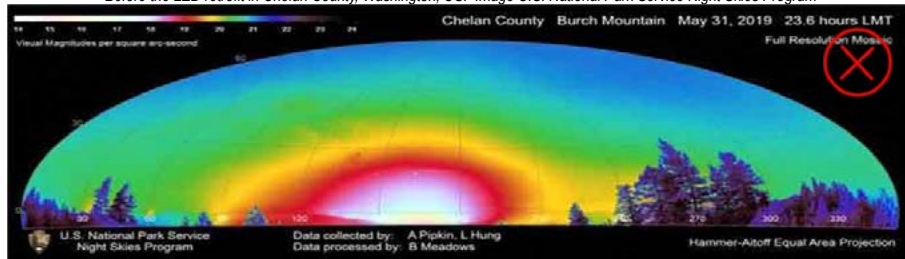
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White LEDs Increase Light Pollution

When Chelan County, Washington, replaced 3,693 street lights with full-cutoff LEDs (80% are 3000 K and 20% at 4000 K) they hoped to reduce light pollution.⁴⁷ However, the light pollution (sky glow) worsened as shown below.



Before the LED retrofit in Chelan County, Washington, US. Image U.S. National Park Service Night Skies Program



After the LED retrofit in Chelan County, Washington, US. Image Credit: U.S. National Park Service Night Skies Program.

NZ should be wise to heed actions taken overseas to implement responsible lighting.^{48,49,50,51,52,53,54,55} Furthermore, councils have a responsibility to include best lighting practices as policy in their district plans to support sustainability goals and to also help avoid costly errors.⁵⁶

AVOID THESE TYPE OF LED LIGHT SOURCES



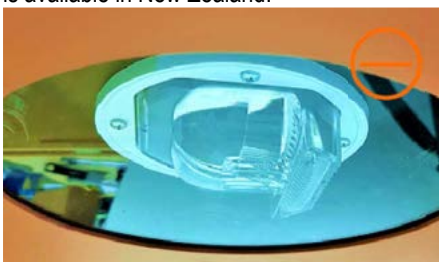
Above, a typical unfit-for-purpose LED.



Close-up of a flat array typical of most LED street lights

CHOOSE IMPROVED LED LIGHT SOURCES INSTEAD

Below left, a 2000 K LED with fully recessed diodes, optics and internal shielding - an improvement on the above LEDs. Below centre/right, integrated lightpipe and microfaceted diamond lens technology so one can look directly at the light in comfort. Ideally, all LED street lights should have similar optics. As the demand for visually comfortable lighting increases, more companies will provide safer options. The Cree Sirius 2700 K LED is available in New Zealand.⁵⁷



Amber 2200 K LED. Image Crossroads Lighting.



Cree Sirius 2700 K LED. Image Cree Lighting.



Cree Sirius 2700 K LED viewed directly. Image Tanya Didham.

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48 - Dark and Quiet Skies for Science and Society: Report and Recommendations. 2021. <https://zenodo.org/record/5898785>

49 - <https://www.iau.org/static/publications/dskies-book-29-12-20.pdf>

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52 - The Government of the Republic of Slovenia Passes a Light Pollution Law. August 2007. <https://starlight2007.net/slovenia.html>

53 - <https://www.slowlight.es/>

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55 - Environment announces new light standard to protect Chile's skies throughout the territory. March 2022. <https://www.induambiente.com/noticias/mma-anuncia-nueva-norma-luminica-que-protectera-los-cielos-de-chile-en-todo-el-territorio>

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Artificial Lighting and its Impact on Human Health

The growing body of evidence about the detrimental effects of exposure to artificial light at night (ALAN) confirms we need darkness to thrive. This means darkness needs to be valued and considered in all scenarios.

For decades the impact of artificial light at night (ALAN) has been underplayed as a “soft” issue, yet this couldn’t be further from the truth.⁵⁸ Both ALAN and the light pollution it generates have an adverse impact on every biological process in the human body. Science now confirms that adequate exposure to sunlight during the day along with sufficient natural darkness at night both play an critical, intertwined role in health and wellbeing that starts in the womb, and continues throughout our lifetime.⁵⁹

Listed below are just some of the effects of ALAN and the research that now exists.

Nighttime light pollution is linked to preterm birth.⁶⁰

Research suggests there is high sensitivity of melatonin suppression response to evening light in preschool-aged children.⁶¹ Preschool-aged children are highly sensitive to light exposure in the hour before bedtime and this suggests the lighting environment may play a crucial role in the development and the maintenance of behavioral sleep problems through impacts on the circadian timing system. This heightened sensitivity to light may make them even more susceptible to dysregulation of sleep and the circadian system.

Adverse changes to metabolism.⁶² Exposure to unnatural artificial lighting at night coupled with low exposure to natural sunlight during the day, raises the risk of developing metabolic diseases.⁶³ Light exposure at night impairs cardiometabolic function and even moderate light exposure during sleep harms heart health and increases insulin resistance.^{64, 65}

Exposure to outside light at night is linked to mood disorders and sleep patterns among US adolescents.⁶⁶

Breast, prostate and colorectal cancer.^{67,68} Previously it was believed the risk was limited to night-shift workers, but a study showed that across demographics and professions, exposure to light at night for any reason is correlated with elevated breast cancer risk.⁶⁹

Higher risk of developing autism.⁷⁰

Risks to infants eyes. The possible damage to the delicate, developing eyes of infants and very young children who, tend to look directly at light sources (from their position in strollers and lack of developed common sense not look/stare directly at the light sources. This is especially important with unfiltered, non-diffused, exposed LED diodes/chips.

It’s not just the visual system that’s stimulated by light. Blue wavelengths of light have broad ranging, complex and cascading biological effects in living organisms. In humans this includes amongst others, the flight and fight response, pupillary response, and even urination.

Parkinsons.⁷¹

Recovery from cerebral ischaemia.⁷²

Even a small amount of light can harm our sleep and humans are far more sensitive to light at night than previously assumed.⁷³

Other studies confirm the importance of darkness at night for recovery in hospitals.

The precautionary principle applies to exposure to artificial light because we simply don’t know enough about circadian health.⁷⁴

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66 - Association of Outdoor Artificial Light at Night With Mental Disorders and Sleep Patterns Among US Adolescents. July 2020. <https://jamanetwork.com/journals/jamapsychiatry/article-abstract/2767698>

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72 - Dim light at night impairs recovery from global cerebral ischemia. 2019. <https://www.sciencedirect.com/science/article/abs/pii/S0014488618302772?via%3Dihub>

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Responsible Lighting to Protect Ecology

Although different organisms vary in their responses to different wavelengths and intensity of light,^{75,76} best lighting practices can minimise the impact of artificial lighting at night (ALAN). ALAN ranks amongst the most pervasive global threats to biodiversity conservation,^{77,78,79} (30% of vertebrates and 60% of invertebrates that are nocturnal are exquisitely sensitive to light). One reason white LEDs are problematic is that they emit broad range light. The broader the spectrum of artificial light, the broader the group of organisms that are affected by it. Flora, fauna, and single cell organisms such as bacteria can all be impacted, and light pollution is recognised as a major driver of insect declines.^{80,81} Studies also show exposure to street lights can adversely harm trees and plants in many ways, effecting bud burst, pollen availability, greening of leaves and leaf fall.⁸² These impacts have multiple disruptive, complex, cascading consequences across all species so best lighting practices are critical. Lighting can act like a physical barrier to many species, which prevents them from moving around habitats and undertaking essential behaviours that support biodiversity.

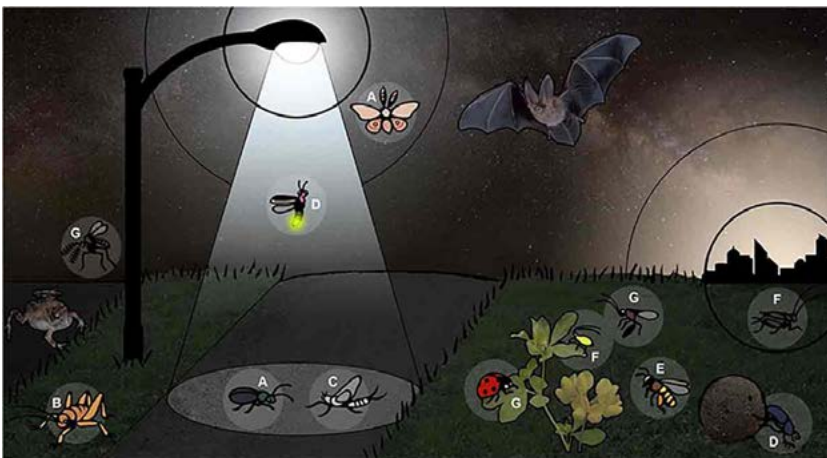
Important Factors to be Aware of

- Wildlife can be negatively affected by light pollution at levels that are undetectable to humans.¹⁵
- Although amber LED light sources are generally less disruptive to wildlife, there's no such thing as "nature-friendly" lighting, so always use shielded LEDs, and when possible, LEDs with diffusers that cover the diodes and integrated optics such as lightpipe technology.
- Select LEDs with a low lumen output, and apply dimming, timers and/or auto sensors.
- Avoid illuminating gardens, trees, and pools, and limit or avoid the use of exterior LED fairy lights.
- Avoid lighting that shines into, and reflects on bodies of water such as ponds, streams, rivers, lakes, and the ocean.
- Apply nocturnal placemaking where areas are intentionally left to be naturally dark to protect ecology.
- Consider less disruptive lighting alternatives such as glow-in-the-dark materials.

Key for Infographic on the left

Artificial light at night (ALAN) adversely effects living organisms in the following ways:

- A - Fatal attraction.
- B - Avoidance.
- C - Lays eggs in wrong places.
- D - Obscures natural lights which interferes with navigation, foraging, and reproduction.
- E - Circadian patterns disrupted.
- F - Alters development + phenology (the periodic biological phenomena, such as flowering, breeding, and migration, in relation to climatic conditions.)
- G - Food webs are disrupted.



Infographic taken from the 2019 study *Light Pollution Is a Driver of Insect Declines*. Image by Avalon Owens.

Moths and Insects

The insect apocalypse is linked to ALAN with broadspectrum, white light being the most problematic.^{83,84,85,86,87,88} NZ has 1983+ species of native moths, most of which are nocturnal. Moths are essential pollinators. (Think of them as butterflies of the night.) Many other insects require darkness to thrive, such as 100+ species of wētā, titiwai (glow worms), huhu beetles, and up to 30 different species of ngaokoeko (velvet worm). Other natives also play a pivotal role in our ecosystem such as 25 species of native cockroaches, 2000+ species of spiders, and many species of crickets, slugs, snails, caterpillars, flies, and flat worms. Light from white LED street lights that shines onto asphalt and water can act as an ecological trap. Water is highly reflective and it also absorbs light so the problems of ALAN are magnified when light trespasses on/into water. This means lighting near water needs to be minimised and controlled.

Riparian, Aquatic and Marine Ecology

ALAN is also detrimental to riparian, aquatic and marine ecology,^{89,90,91,92,93,94} and nocturnal species are particularly vulnerable.⁹⁵ In NZ this can impact kōura (crayfish), long-finned and short-finned eels, sea urchins, spider crabs, sea worms, brittle stars, tube anemones, seahorses, and feather stars. Also zooplankton and bio-luminescent plankton are active at night, as are squid, the Dusky dolphin, and native species of inanga/ inaka (whitebait). The health and biodiversity of ecology and the waterways that support it necessitate best lighting practices.

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87 - Multiple night-time LED lighting strategies impact grassland invertebrate assemblages. January 2017. <https://onlinelibrary.wiley.com/doi/10.1111/gcb.13615>

88 - Artificial nighttime lighting impacts visual ecology links between flowers, pollinators and predators. July 2021. <https://www.nature.com/articles/s41467-021-24394-0>

89 - A global atlas of artificial light at night under the sea. December 2021. <https://online.ucpress.edu/elementa/article/9/1/00049/119144/A-global-atlas-of-artificial-light-at-night-under>

90 - Biologically important artificial light at night on the seafloor. July 2020. <https://www.nature.com/articles/s41598-020-69461-6>

91 - A global atlas of artificial light at night under the sea. December 2021. <https://online.ucpress.edu/elementa/article/9/1/00049/119144/A-global-atlas-of-artificial-light-at-night-under>

92 - Artificial Light at Night Affects Organism Flux across Ecosystem Boundaries and Drives Community Structure in the Recipient Ecosystem. October 2017. <https://www.frontiersin.org/articles/10.3389/fenvs.2017.00061/full>

93 - Urban light pollution alters the diel vertical migration of Daphnia. January 2001. https://www.researchgate.net/publication/233966352_Urban_light_pollution_alters_the_diel_vertical_migration_of_Daphnia

94 - Artificial light at night causes reproductive failure in clownfish. July 2019. <https://royalsocietypublishing.org/doi/10.1098/rsbl.2019.0272>

95 - Light pollution in the sea. 2010. https://www.researchgate.net/publication/45827459_Light_pollution_in_the_sea

Birdlife, Bats and Reptiles

The adverse impact of ALAN on ecology, especially from white LEDs is backed up by research.^{96,97} Ecologists strongly advise minimising exposure to ALAN and avoiding white LED light sources. This is particularly relevant in NZ as many native bird species are nocturnal, including the endangered Hutton's shearwater, the critically endangered Whenua Hou diving-petrel, as well as most other shearwater and petrel species, five species of kiwi, the kākāpō (the world's only nocturnal parrot), kororā (little blue penguin), the ruru owl, and kaka, and more. NZ is also home to two threatened species of pekapeka (bats) which need darkness at night. Additionally, four species of native frogs, many species of skinks and geckos (most of which are threatened or at risk of extinction), and the rare tuatara are nocturnal. Unfortunately, the high intensity of light emitted by LED street lights and the reflectance of their light on roads can attract and disorientate sea-faring birds, also causing them to become grounded and vulnerable to predation and harm from road traffic on land. Service stations and dairy farms in particular, need to apply responsible lighting to avoid attracting the Hutton's shearwater to brightly lit structures.

Plants and Trees

Whenever possible minimise illumination in areas of greenery because plants and trees require darkness at night. Disrupting their natural day/night cycle with ALAN disrupts important biological processes which ultimately damages the foodchain and reduces biodiversity. (Some native NZ plants and trees evolved strong scents to attract moths at night, such as the Raupeka (the endemic Easter orchid), Māhoe, and some pittosporums.)

96 - LED-lighting influences the activity of bats. Sept 2016. <https://www.sciencedaily.com/releases/2016/09/160901093006.htm>

97 - Nocturnal lighting in animal research should be replicable and reflect relevant ecological conditions. March 2022. <https://royalsocietypublishing.org/doi/10.1098/rsbl.2022.0035>

Responsible Lighting Around the Home

AVOID

Harsh, glary, white lighting.



IMPROVED

Shielded, soft, low lumen, amber lighting.



OPTIMAL

Lights turned off. Activated via sensors/timers.



Responsible Lighting Near Water

Light clutter, harsh, glary, white light.



Minimal, shielded, low output, amber lighting.



Lights turned off. Activated via sensors/timers.



Unshielded, white lighting on tall poles.



Shielded, recessed, low set, amber LEDs.



Lights turned off. Activated via sensors/timers.



Image Form and Light. formandlight.com.au

Dawlsh, Devon, UK, DW Windsor Lighting. Image Andrew Hatfield.

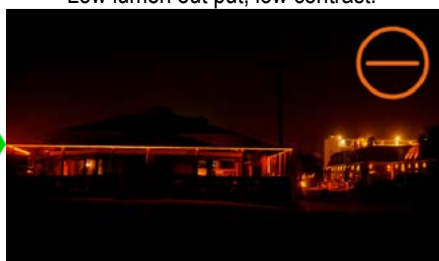
Fort Jefferson Seawall, Florida, US. Image QT Luong.

Responsible Lighting for Businesses

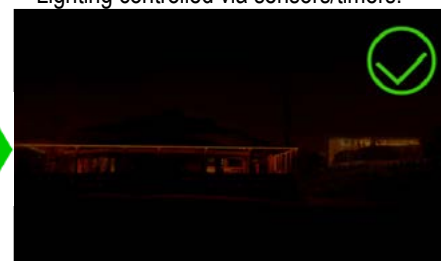
Unshielded, glary, horizontal lighting.
High lighting levels, high contrast.



Shielded, soft, warm, amber lighting.
Low lumen output, low contrast.



After closing, lighting is dimmed or off.
Lighting controlled via sensors/timers.



O'Shucks / Trader Ricky's Restaurant, Cocoa Beach, Florida.

The same venue with improved, ecologically responsible lighting.

After closing -, if the same venue lowered their lighting even more.

Responsible Outdoor Lighting Guidelines for Surfaces and Materials

Ensure windows have effective blinds and/or shutters to prevent interior light escaping outside. Close them when it gets dark.

Ensure lights are not directed towards reflective surfaces.

Choose dark, textured surfaces listed below, to reduce reflectance from light sources.

SURFACE	REFLECTIVE PROPERTIVES	SUITABILITY
Natural grass and vegetation	Low	Best ✓
Weathering steel / Corten steel (rusted effect)	Low	Best ✓
Brick (dark)	Low	Best ✓
Brushed tinted concrete (dark)	Low	Best ✓
Painted surface (dark and matt)	Low	Best ✓
Pre-coloured factory metal (dark)	Low	Best ✓
Raw / stained timber	Medium	OK
Stone surface	Medium	OK
Smooth light-coloured concrete	High	Avoid ✗
Painted surface (light)	High	Avoid ✗
Artificial grass (sand base)	High	Avoid ✗
Brick (light)	High	Avoid ✗

Darker coloured, pervious, permeable, and porous surfaces for pavements, driveways and courtyards are helpful to manage stormwater. They can also help to reduce light pollution as the surfaces are textured and therefore, less likely to reflect light from streetlights and other light sources.

Responsible Outdoor Lighting Infographics

AVOID

Unshielded, glary, white lighting.
Horizontal lighting. High output.



IMPROVED

Shielded, soft, amber lighting.
Vertical lighting. Low lumen output.



OPTIMAL

Lights turned off.
Lighting controlled via sensors/timers.



Horizontal lighting. High lighting levels.
Glare, light trespass, light nuisance.



Vertical lighting. Lower lighting levels.
Warm, well directed with no light nuisance.



Lights turned off. Activated via sensors/timers.
Lighting is warmer and dimmed.



Unshielded, harsh, white, horizontal lighting.



Shielded, soft, warm, vertical lighting.



Lights turned off. Activated via sensors/timers.



Horizontal lighting. Light clutter. High output.
Uncontrolled, harsh, glary, white lighting.



Vertical lighting. Low lighting levels.
Controlled, shielded, warm light.



Lights turned off.
Activated via sensors/timers.



Unshielded, glary, white light source.



Shielded, soft, amber light source.



Lights turned off.
Activated via sensors/timers.



Responsible Outdoor Lighting Guidelines for Buildings, Landscapes and New Subdivisions

Please see the brief outlines, followed by infographics and photographic examples of what to avoid, along with examples of responsible lighting and what to do instead to make improvements. Refer to Responsible Lighting Fixtures pg 14 when selecting light sources. Bollards are an effective way to illuminate streets, paths, steps, and cycleways, and they are a modern and sustainable way to light new developments instead of using streetlights. They keep light close to the ground and reduce maintenance costs whilst improving safety, enhancing the ambience of neighbourhoods, and improving the curb appeal of properties. With bollards, the bulb/diodes should be hidden to eliminate glare, improve visibility, and to reduce light pollution and harm to wildlife. Favour amber (1600-2200 K) however 2700-3000 K is acceptable as long as the bollards are well-designed. Select low lumen output LEDs to keep lighting levels low, apply dimming, and operate via sensors and/or timers.

AVOID

Unshielded, harsh, high-intensity, white light.
Unsafe and light polluting.



Image source unknown.

IMPROVED

Controlled, shielded, warm light.
Invest in well-designed LEDs. (Less is more.)



Image Targetti Lighting.

OPTIMAL

Lighting is off, and when it's needed,
turns on via sensors/timers.



Image pxhere.com

Harsh, high-intensity, white light.



Image source unknown.

Low level, warm light. Recessed diodes/bulbs.



Image Targetti Lighting



Image pxhere.com

High-intensity, glary, white LEDs.



Image source unknown.

Low level, warm lighting. Recessed diodes/bulbs.



Indian Rocks, Florida. Image First Light Technologies.



Newprt Stat Park, Wisconsin. Image www.goodfreephotos.com

Light clutter and white LED light sources.
Poor placement. Unshielded LEDs.



Image source unknown.

Indirect, evenly dispersed lighting.
Light should be warmer with a lower output.



Image OOO LPM-Complex.



Image-joinn.com

Bollards are too close to the water.
Unshielded and an inappropriate colour.



Image source unknown.

Bollards face away from the water.
Light is soft and low to the ground.



NBA LEDs to protect sea turtles. Clearwater Beach, Florida. Image Jim Damaske

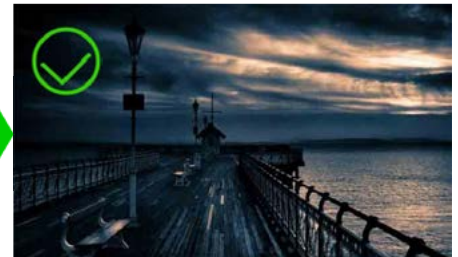


Image mamabearapp.com

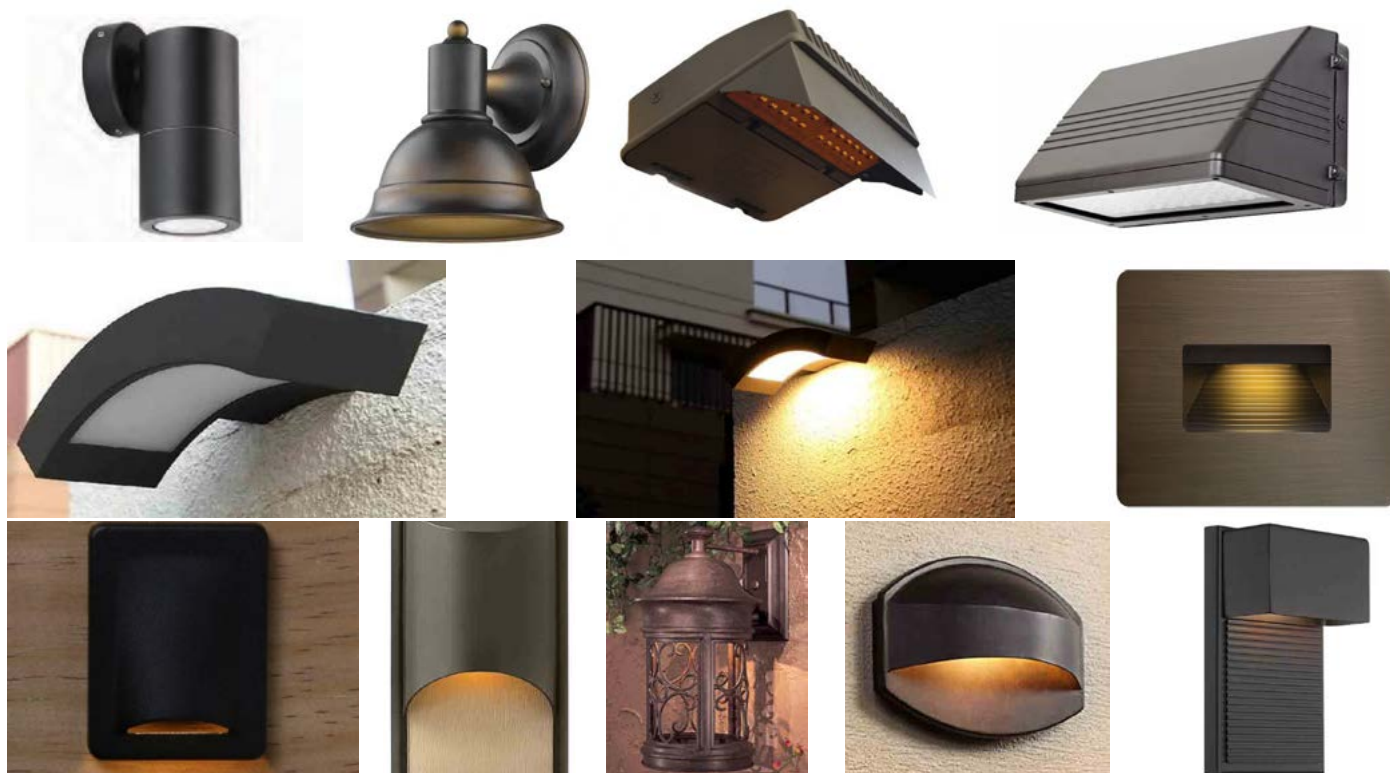
Responsible Exterior Lighting Fixture Guide

The examples on this page show what to look for when selecting LED light fittings. Note that they have recessed/hidden diodes to mitigate excess radiance and glare. The aim is to provide light that is indirect and soft on the eye which assists visibility and comfort. These fixtures also enhance the ambience of a space making areas much more comfortable to be in and safer to navigate.

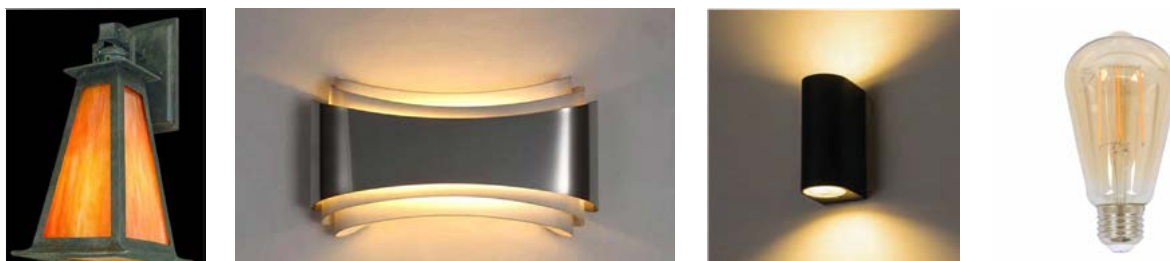
Luminaires should be fully shielded, full cut-off (with shielded/recessed and/or covered/hidden bulbs/diodes). Some have a frosted covering to reduce glare. Light is directed downwards and is soft, diffused, evenly distributed, and warm in colour/spectrum (1600-2200 K). Wall mounted light sources that emit light upwards are acceptable as long as they are positioned under a balcony or the eaves of a building so the upwards light is capped to prevent it from escaping into the sky.

Availability

Hardware and lighting suppliers in NZ stock white LED light sources (3000-6000 K) for exterior illumination. Some offer 2700 K, however these often need to be requested, and as yet, exterior amber LED light sources (1600-2200 K) aren't widely available. If you cannot find what you're looking for, make a request with your stockist to order the product in. There are 2200 K LEDs (mainly mock filament edison bulbs) for interior lighting on the market, and as the tiny LED chips are exposed, they're best used with lampshades. Again, make a request. As stockists respond to the demand for safer lighting, these kind of fixtures, lamps and bulbs will become more common.



Below left, the fixture below is acceptable because the colour is very warm, and the lighting indirect and soft. Below (second from the left), although not as ideal, the next two fixtures below are acceptable as long as the light that's directed upwards is capped effectively by a ledge or eave. Below right, 2200 K mock filament edison LED bulb, best used with lampshades, as the even though the LED diodes are tiny, the light they emit is still very bright. (Please also see blue blocking LED bulb options for interior lighting on pg 58.)



Responsible Lighting for Steps, Decks, Ramps, Handrails, Decking and Pavements

Ensure lighting is recessed and positioned so the diodes/chips/bulbs are hidden or covered as shown below, and that the light that's emitted is soft, diffused, evenly distributed, and warm in colour (1600 – 2200 K). (Keep in mind the disadvantage with solar LEDs is that they remain on for as long as the charge lasts. Ideally, all exterior lighting can be turned off when needed, and operated via timers and/or sensors.

IMPROVED



US Court House Annex, San Diego, California. Image source unknown.

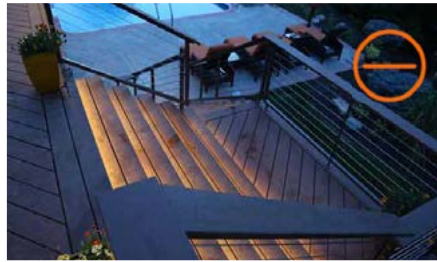


Image McKay Landscape Lighting, Omaha, US.



Image www.wagnerarchitectural.com



Image majesticoutdoorlighting.com



Image majesticoutdoorlighting.com



Museum Bavarian Kings, Hohenschwangau, Germany. Image EWO Lighting.

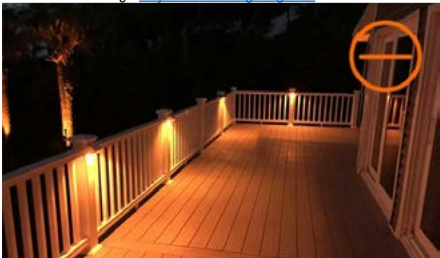


Image Lanai Lights.



Image source unknown.



Image source unknown.

Below right, ideally, the lighting below is warmer with lower output.



Amber Solar Deck Lighting. Image amazon.com



Image source unknown.



Bevel Apartments, ODA, New York. Image Aaron Thompson.



Amber Solar Step Lights. Image amazon.com



Image source unknown.

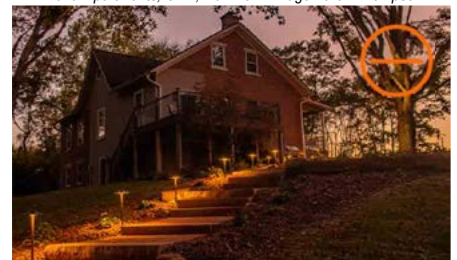
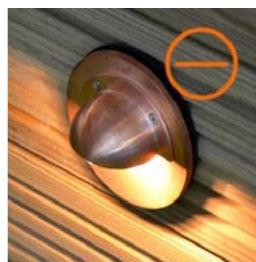
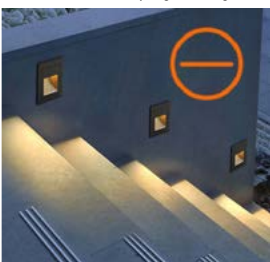


Image Auman Landscape...aumanlandscape.com



Responsible Lighting for Residential Homes

Avoid “vanity” lighting, overlighting, and white light (below left). Avoid harsh, white lighting (below left/centre/right), and light clutter (below right.)

AVOID



Image Soffit Lighting. Pauls Electric-Service.



Image wagnerarchitectural.com.



Image source unknown

Avoid overlighting (below left), horizontal lighting and glare (below centre), and white lighting (below right).



Image source unknown.



Image Kyra Xavia



Image source unknown.

Bollards are an effective solution. Apply well-designed, thoughtfully positioned amber bollards to keep light close to the ground and reduce maintenance costs. This provides adequate illumination whilst minimising the negative impact of lighting on human health, the ecosystem, environment, and night sky. It also improves safety, enhances the ambience of neighbourhoods, and improves the curb appeal of properties. The diodes/chips/bulbs should be hidden from view to eliminate glare, improve visibility, and reduce light pollution and harm to wildlife. All light should be directed downwards. If directing lighting upwards (with wall mounted light sources), ensure it is capped by the eaves of the roof so it doesn't shine into the sky. Favour warm, amber lighting (1600-2200 K) however, 2700-3000 K is acceptable as long as the light source is well-designed, and low lumen output LEDs are selected to reduce lighting levels. Also ensure dimming, sensors and/or timers are used when possible. The following examples show the kind of illumination to aim for in residential lighting: warm, soft, subtle, indirect, well-placed, glare-free, low level lighting.

IMPROVED

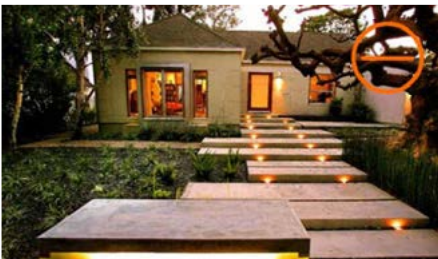


Image source unknown.



Image source unknown.



Image source unknown.

In the examples below, ideally the colour of light would be warmer and lighting levels were lowered..

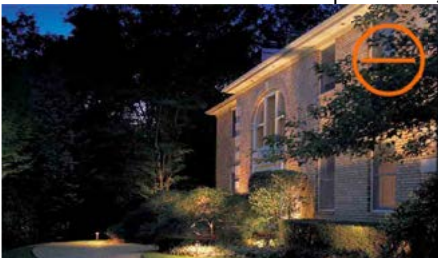


Image outdoorlights.com



Image marylandlighting.com



Image darksky.org

Below left, well-controlled, warm, soft, evenly dispersed, low level lighting. Below centre, well executed, responsible lighting.



Image www.mydeck.com



Image source unknown



Image Naomi Arnold.

Responsible Lighting for Architecture, Buildings, Businesses, ATMs

Avoid harsh, glaring, high-intensity, white lighting that reduces visibility and compromises safety, health and wellbeing, as shown below left. Whereas, softly dispersed, evenly distributed, well-directed, glare-free, amber light supports vision, safety, comfort, sleep, and health as shown below right.



Images mcdonaldobservatory.org

IMPROVED

Well-controlled, low levels of warm, softly dispersed, evenly distributed, vertical lighting (wall washing), with the careful placement of light sources.

The first six images below are taken by Stephen Hummel. McDonald Observatory.



Frama & Tumbleweed Laundry, Marfa, Texas.



Jeff Davis County Annex, Fort Davis Texas.



Big Bend Sentinel Building, Marfa, Texas. Marfa Gardens, Marfa, Texas



Jeff Davis County Courthouse, Fort Davis, Texas.



South Brewster County Emergency Response Centre.



Meridian Water Station, Enfield, UK. Image DW Windsor Lighting.



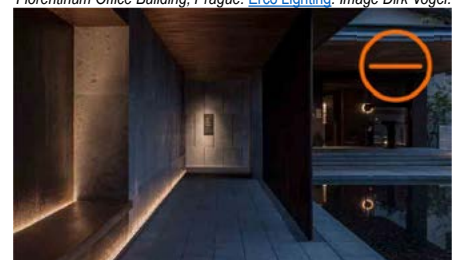
Temple House, Chengdu, China. Image Nick Hughes/Yellowtrace.



Florentinum Office Building, Prague. Erco Lighting. Image Dirk Vogel.



Above left/centre Yunxi Town, Yan Zhangjiakou, Hebei Province China. Images litawards.com.



Buda Hotel, Chengdu, China. Image Chuan HE/Here Space Photography.

Lighting for ATM machines

Below left, unshielded, poorly placed (horizontal), direct, harsh, glaring, white lighting that compromises visibility, safety, navigation and comfort. Below right, the same venue with improved vertical lighting that improves visibility, safety and comfort. Ideally all light sources would be amber in colour.



US Bank, Santa Cruz, California. Image source unknown.

Responsible Lighting for Carparks

Lighting at night in large carparks, should be significantly dimmed, or even better, turned off and activated by sensors so it turns on with activity. The images below, show inappropriate, harsh, glary, unfit-for-purpose, harmful, white lighting. Below left, avoid unshielded, glary, high-intensity lighting, especially near water. Below left/centre, unshielded, glary lighting increases light pollution and compromises health and safety. Below right, although these LEDs have top covers they're still poorly designed and emit an unsafe colour/spectrum of light. They're also glary and harsh.

AVOID



Car Park Lighting, Kaikoura District Council. Image Larry Field.



Image source unknown.

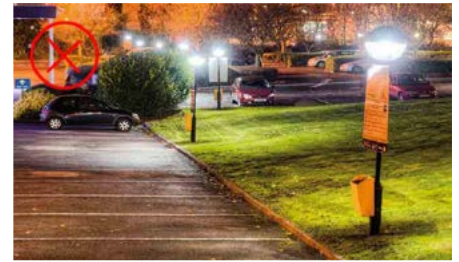


Image germalighting.com

Below left/centre/right, an empty carpark lit up brightly, when no one is using it is a waste of energy and money, and it serves no purpose. Below centre, demonstrates the drawbacks of unfit-for-purpose LED lighting - poor quality light (high-intensity light, non-uniform light distribution and strong contrast). Instead of evenly distributed, softly diffused light that assists vision and illuminates the area, this kind of unsafe lighting creates stark areas of shadow and small hotspots of light that make it difficult to navigate. It also hinders the detection of objects in the shadows.



Image superiorlight.com



Image superiorlight.com



Image www.proccircuitinc.com

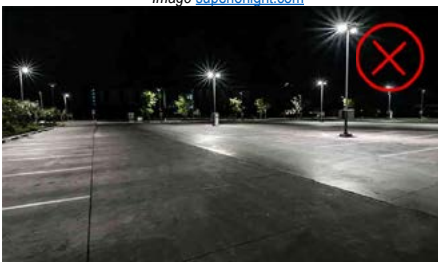


Image www.metcalfelectrical.com



Image source unknown.



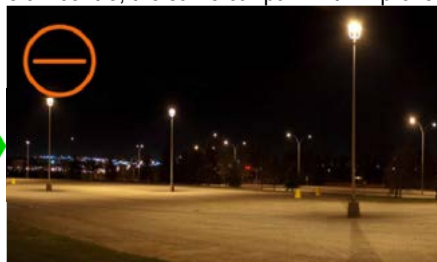
Image www.metcalfelectrical.com

AVOID

Below left, unshielded, uncontrolled, glary light. Below centre, the same car park with improved lighting. (Ideally the diodes/chips are not visible.)



Sherbrooke University Carpark, Québec. Image source unknown.



Sherbrooke University Carpark, Québec. Image source unknown.

OPTIMAL



Carpark with lights turned off. Image JockMcGrumpy www.blipfoto.com

IMPROVED

Ensure lighting is warm, softly dispersed, evenly distributed, well shielded, directed downwards, and use the minimal output required.



Amber 1600 K LED. Christchurch. Image [Energylight](http://Energylight.com).



Hard Rock Hotel, Daytona, Florida. [True Lite Distribution](http://TrueLiteDistribution.com).



Image [Crossroads Lighting](http://CrossroadsLighting.com).

Responsible Security Lighting

Brighter lighting that's left on all night, does not equate to improved safety and less crime. (Refer to Lighting Fundamentals pg 4 and Debunking Common Fallacies pg 6.) It's more effective to turn lights off when not in use, that automatically activate from movement via sensors. This shocks intruders and alerts others to their presence. Criminals need light to do their mischief. If they have to bring a torch, they reveal their whereabouts.

AVOID

Avoid uncontrolled, unshielded, direct, harsh, glary, high-intensity, white light, and leaving lights on all night. Below left, glary, harsh, unsafe, white light causing light trespass. Below centre/right, unshielded, poorly placed, horizontal lighting which produces unpleasant glare and light pollution.



Security lighting off Beach Rd, Kaikoura. Image Larry Field.

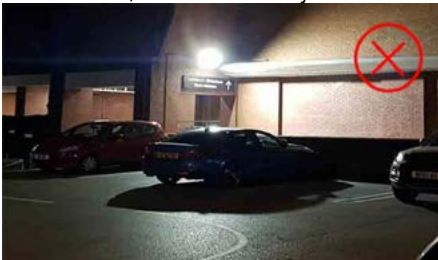


Image source unknown



Image source unknown

Below centre, note how visibility is reduced and how dark and threatening the shadows are.



Sainsbury Supermarket Altrincham, UK. Image Colin Henshaw.



Image source unknown.



Image truelumens.com

Below left, although the white LEDs are shielded, note that the harsh, high contrast lighting reduces visibility. Below right, the same venue with improved lighting (warmer colour and spectrum with lower lighting levels). Note the improved visibility.



Images sources unknown.

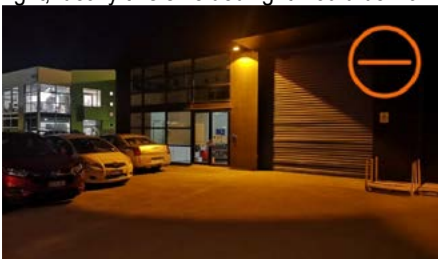
Below left, unshielded, harsh, horizontal, white lighting. Below right, ideally the colour would be warmer and the lumen output lower.



Images Joyce Harman.

IMPROVED

Apply well-controlled, shielded, indirect, soft, glare-free, low intensity, amber, vertical lighting. Use motions sensors/timers. Below left, well-directed, controlled, shielded, glare-free, warm lighting with no unwanted light trespass/light nuisance. Below centre, shielded, warm lighting. Below right, ideally this shielded light would be warmer in colour.



Amber 1600 K LED Energylight, Christchurch, NZ. Image Mike Geddis.



Image source unknown.



PowerDay Recycling Centre, Endfield, UK. Image DW Windsor Lighting.

Responsible Lighting for Landmarks, Historic Sites and Structures

Minimise lighting, ensure it is shielded, well-controlled, soft and warmly coloured, and automatically turns off, or is significantly dimmed at 10 pm in winter and 11 pm in summer. Factor in the environmental impact of illuminating large buildings and historic sites, especially when located near water. Also refer to “Responsible Lighting for Light Festivals, Creative Light Installations, Projection Mapping”. Most importantly, question whether it’s appropriate and if a landmark even needs to be illuminated.

AVOID

Below left, the lighting is well controlled, but it’s best to avoid vivid colours. Below centre/right, vivid coloured lighting which should be avoided.



Westergasfabriek Amsterdam Netherlands Image [CLS Lights](#).



Penshaw Monument, Sunderland, UK. Image Michael Curry..



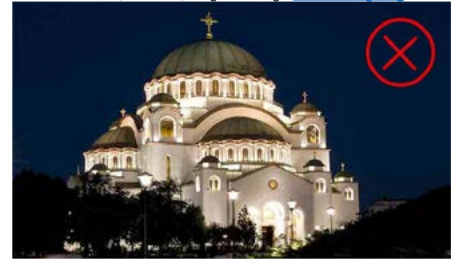
Grote Markt, Brussels, Belgium. Image [Schreder Lighting](#).



Oneness-Temple-Chittoor-Varadaiahpalem-India. Image [illumina.com](#)



Chapel Shanwei, China. [archdaily.com](#). Image Siming Wu.

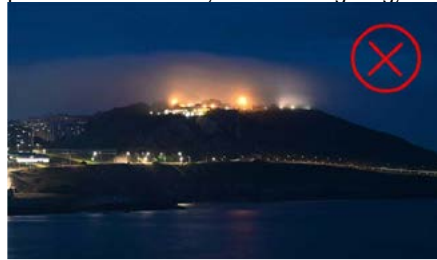


St Sava Orthodox Cathedral, Belgrade, Serbia. Image [Schreder Lighting](#).

Below left, irresponsible, insensitive, crude, white, high-intensity, overlighting of a historic landmark, causing excessive light pollution. Below centre, poorly executed lighting. It’s unshielded, poorly positioned, and far too bright even if some of the light sources are amber in colour. Below right, this beautiful historic building would be better complimented with softer, less harsh lighting, that is warmer in colour and spectrum.



Mont Orgueil Castle, Jersey. Image [invi.co.uk](#)



Monte San Pedro, La Coruna, Spain. Image Alberto Giachi.



Brussels, Belgium. Image [Schreder Lighting](#).

Below left, illuminating water in natural environments like this is irresponsible and inappropriate. Due to the multiple adverse effects of ALAN we must accept that the importance of protecting such habitats far out weigh the novelty factor of entertaining visitors. Below centre, projection mapping and below right, vividly coloured lighting.



Niagara Falls, Ontario, Canada. Image [Cater News Agency](#).



Sharjah Light Festival. Image [ImagineWhat Flickr.com](#)



St-Josephs, Angers, France. Image [Schreder Lighting](#).

Below left, 40 historic buildings along the waterfront on Shanghai Bund are now illuminated by a dynamic light show with 50,000 tunable white LED façade lights. The Bund is also part of a lighting scheme that includes three bridges and 77 buildings in the financial and tourist districts.



The Bund, Shanghai, China. Image [Signify](#).

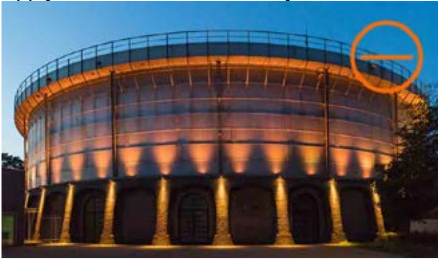


Falkirk Wheel Experience, UK. Image [Madeleine Gallacher Photography](#).

Responsible Lighting for Landmarks, Historic Sites and Structures

IMPROVED

Apply well-controlled, carefully directed, low-intensity, warm, amber lighting, that is complementary to both the architecture and its setting.



Westergasfabriek Amsterdam Netherlands Image [CLS Lights](#).



Knox Church Christchurch, NZ. Image Kevin Cawley. [Lighting Design](#).



Iglesia de San-Pedro, Ávila, Spain. [iGuzzini](#), Image Gala Martinez.



Riggio Lynch Interfaith Chapel. [Tillet Lighting](#). Image Timothy Hursley.



Arsenali Republican, Pisa, Italy. Image [EWO Lighting](#)



Sharjah Mosque, UAE. Image Khatcho Demergian.



St Josephs Church, Angers, France. Images [Scheder Lighting](#) [schreder.com](#)



Camel's Fort, Melilla, Spain. [led-linear.com](#) Image Martin Garcia Perez.

Below left, ideally the colour would be warmer with lower lighting levels. Below centre, well-controlled, subtle, warm lighting at Sydney Observatory.



Calgary City Hall, Calgary, Canada. Image Chan Rin Vivid Ribbon Inc.



Sydney Observatory, Australia. Images [Ercol Lighting](#).



Sønderborg Castle, Sønderburg, Denmark. Images [Frederik Waneck Borello](#) [lightbureau.com](#)



Below left, soft, warm, low level lighting of Fulda Cathedral, Germany in the Fulda Dark Sky Community in Germany. Below centre, the lights on this historic landmark are turned off at 11 pm every night.



Image [darksky.org](#)



Image [Kerem Ali Asforugul](#).

Responsible Landscape Lighting

AVOID

Due to the adverse impact of lighting, trees and foliage should not be illuminated. If lighting is used, minimise it and avoid white and/or vividly coloured light sources, harsh, intensely bright lighting, especially spotlights, and directing light upwards, as well as wrapping branches and tree trunks with fairy lights and stringing them with coloured lights. Avoid lighting trees near water as water reflects light, increasing light pollution. Most solar garden lighting is problematic as often the light is harsh white and it remains on for as long as the charge lasts. It's better to control lighting via automatic timers and/or sensors. Even if the bulbs/diodes are covered, white lighting is inappropriate. Although amber and red lighting is generally less disruptive to wildlife and insects than broad spectrum white lighting, plants and trees are still adversely effected. If you want your garden to thrive and you care about biodiversity, **avoid garden and landscape lighting all together.**



Image sources unknown.



Image sources unknown.



Image sources unknown.



Image sources unknown.



Image ewingaquatech.com



Image sources unknown.



Image sources unknown.



Image freshnist.com



Image source unknown.



Image source unknown.



Image www.outdoortheme.com



Image walmart.com



Image aliexpress.com



Image desertcart.lk



Image truelumens.com



Iguzzini Typha Floor Lamp. Image iGuzzini.

Responsible Lighting for Landscaping and Outdoor Living

IMPROVED

If lighting is used, keep it indirect, soft, and warm, and keep lighting levels low. Instead of focusing on foliage, illuminate vertical surfaces like walls, and light the pathways instead of plants. Aim to create a safe haven for ecology. Also ensure the bulbs/diodes are hidden or covered. Lighting should be soft, easy on the eye and pleasant to look at - and it should be controlled by automatic timers and/or sensors so it switches on only when necessary. Although amber and red lighting is generally less disruptive to wildlife and insects than broad spectrum white lighting, plants and trees are still adversely effected. If you want your plants and trees to thrive and you care about biodiversity, **avoid landscape lighting all together**. Below left, light illuminates the wall instead of being focused on foliage. Below right, ideally there would be less lighting on the plants.



Hard Rock Hotel, Daytona, Florida. Image [True Lite Distribution](#).



Image [Lanai Lights](#).



Taronga Zoo, Sydney, Australia. [Lucian Light](#), Image Brent Winstone.

Below left, well-controlled warm lighting. Below centre, light is on steps and inside the pergola, and the light is warm and well-directed.



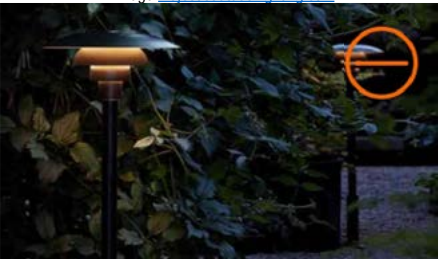
Image [majesticoutdoorlighting.com](#)



Image source unknown.



Image source unknown.



Bollard PH 3-2.5 Floor Lamp by Louis Poulsen. Image [Louis Poulsen](#).



Amber solar garden lights. [www.truelumens.com](#)

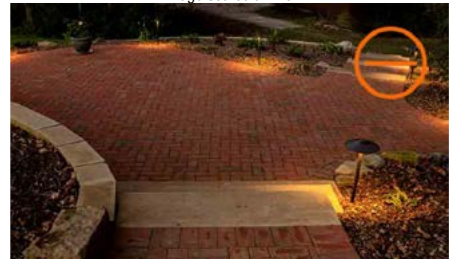
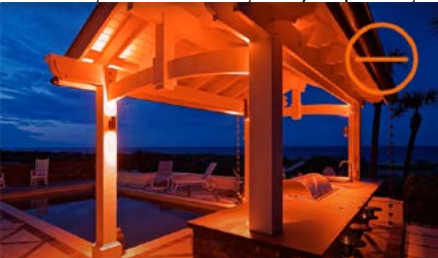


Image source unknown.

Below left, well-controlled, softly dispersed, warm lighting for the pool BBQ area. Below centre, subtle, warm, well-controlled, recessed lighting.



Ecologically responsible lighting. Image [outdoorlights.com](#)



Image [loraxdesigngroup.com](#)



Image [clcdesign.com](#)

Below left and centre, light is warmly coloured, soft and indirect and the diodes/bulbs are covered.



Image [outdoortheme.com](#).



Image [outdoortheme.com](#).

Responsible Lighting for Bridges

AVOID

It's critical bridge lighting is carefully positioned to avoid light spill onto/into the water. LED light sources must also be fully shielded with recessed diodes/bulbs. Ideally lighting is kept low to the ground as this makes it easier to control and reduces the risk of light spill. Avoid unshielded, white lighting on tall poles and/or high on the structure as this can worsen reflections on water and significantly increase light pollution. Avoid uncontrolled, harsh, glary lighting, overlighting, light clutter, and using vivid colours.



Acworth Pedestrian Bridge Georgia, USA.



Image source unknown.



He Ara Kotahi Bridge, Palmerston North. Image Murray Wilson.



Bay Bridge, San Francisco. Image Jesse Collins unsplash.com



Harstine Island Bridge, Mason County. US. Image source unknown.



Cape Town Port Captains Building & Swing Bridge. Image Philips.



Auckland Harbour Bridge. Image www.aecilluminazone.com



Victoria Bridge, Hamilton, NZ. Image Joshua Middleton.



Bosphorus Bridge, Istanbul, Turkey. Image Hülki Okan Tabak unsplash.com

Below centre, although the bridge is lit by amber light, it's unshielded, over lit, too bright and the light sources are too close to the water.



Image source unknown.

IMPROVED

Control lighting to minimise light spill. Keep lighting low to the ground, ensure it's indirect, warm, soft, evenly dispersed, shielded, and recessed.



Amber LED lighting Pedret Bridge, Girona, Spain. Image [Ignia Lighting](https://ignia-lighting.com).



Cernay, France. ledlinear.com. Image Ludovic Loewert.



Pamplona, Spain. ledlinear.com Image Pedro Pegenaute.



Midgarsormen Bridge, Stavanger, Norway. [ERCO Lighting](https://ercolighting.com). Image Johan Elm.

Responsible Lighting for Sports Grounds, Stadiums / Arenas, Skate and Pump Parks, Recreational Spaces

AVOID

Avoid unshielded, uncontrolled, poorly directed, high levels of harsh, glare, white light.



Kaikoura Sports Ground Lighting. Image Larry Field.



Image source unknown.



Image britecourt.com.



Image inui.co.uk

Below left, light pollution and extreme glare from poorly installed sports lights in Waikouaiti, Dunedin, viewed from over 2 km away. Below centre, light from the same sports lights illuminating the cliff face of Matanaka over 500 m away, as well as the ocean. Below right, extreme light trespass from the lights on the nearby pine plantation and Hawksbury Lagoon Wildlife Refuge. The area is home to endangered bird native species.



Light pollution from rugby grounds, Waikouaiti, Dunedin, NZ.

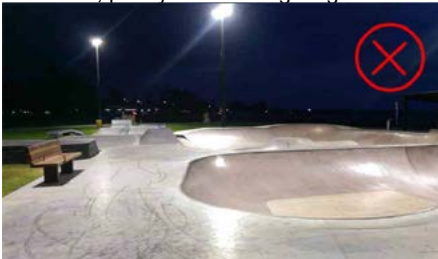


Extreme light trespass on Matanaka and the sea.



Extreme light trespass from the sports lights. Image Kyra Xavia.

Below left, poorly executed lighting in a and recreational skate park. Harsh, glare, white lighting that's also an unsafe colour/spectrum.



Above left/centre, Esperance Skate Park, Esperance, Western Australia. Image source unknown.



Image Chuttersnap unsplash.com



Below left/centre, the Musicon Path pump track in Denmark. Although the lighting is better compared to the above examples, vivid colours and white light should be avoided. Unfortunately, when the pump track is not in use the track is displayed as a sculpture in a cold white light.



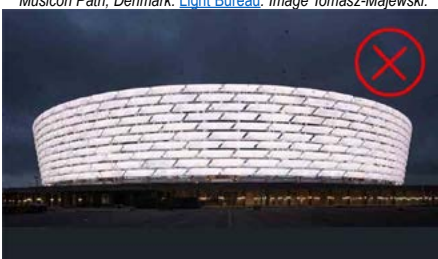
Musicon Path, Denmark. [Light Bureau](https://lightbureau.com). Image Tomasz-Majewski.



Musicon Path, Denmark. [Light Bureau](https://lightbureau.com). Image Frederik Waneck Borello.



South Hedland Skate Park, Australia. Image skateparkhunter.com



Olympic Stadium Baku, Azerbaijan. Image Toca Heerim Rosetti.



Ice Ribbon Stadium, Beijing, China. Image Populous.



Allianz Arena Munich, Germany. Image [Herzog & de Meuron](https://herzogandde.meuron.com).

IMPROVED

Below right, although the lighting levels in are still too high and the white light is inappropriate, note the reduction in light pollution from the image on the left, for the same venue.



Arizona Stadium University, Tucson, Arizona. Images [Monrad Engineering Inc.](#)

In the examples below, the lighting is more controlled, and in some cases, the light is a more appropriate colour/spectrum. Below right, exemplary lighting. Lighting levels are also lowered and light is evenly distributed and soft on the eyes (no glare).

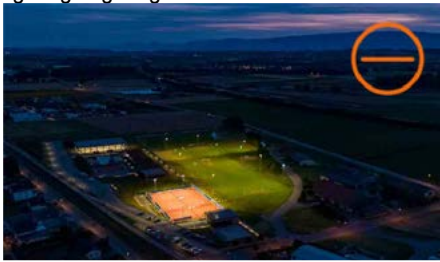


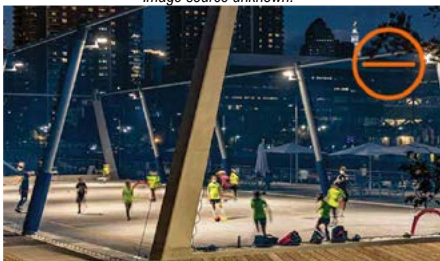
Image source unknown.



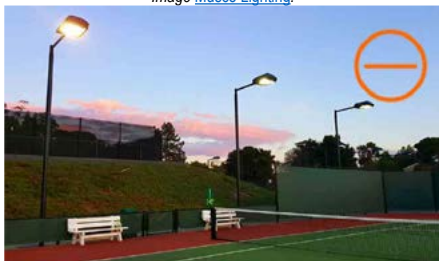
Image [Musco Lighting.](#)



Recreational Court, Sint Andries, Anvers, Belgium. [Schreder Lighting.](#)



Pier 26, Hudson River Park, NYC. Image Barrett Doherty.



Freemont Hills Country Club. Image [vintagecontractors.com](#)

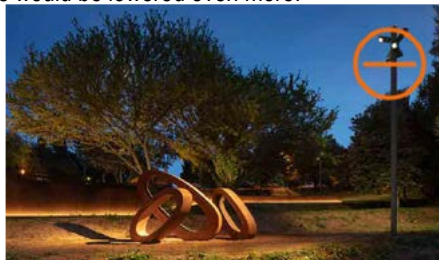


Image [vintagecontractors.com](#)



Birdland Mini Park, Des Moines, Iowa, US. Image [Musco Lighting.](#)

Below left/centre/right, thoughtfully executed lighting for a park. It's well-controlled, warm, glare-free, softly dispersed lighting. Ideally, there would be less lighting on the trees and the lighting levels would be lowered even more.



Various photographs of Verudela Art Park, Pula, Croatia. Images Jan Stojkovic. [deltalight.com](#)

Responsible Lighting for Pathways and Cycleways

Avoid unshielded, poorly controlled, harsh, glary, white light, especially near water. Avoid light clutter, lights on tall poles, as well as unshielded globe and acorn style lamps which spill light. Below left, inappropriate, unsafe, unfit-for-purpose white LEDs in Central Park, New York. Note how threatening the dark areas are due to strong contrast and glare. Below right, a larger photo of Central Park with unfit-for-purpose white LEDs. Illuminating parks as if it were day, damages ecology which is crucial for the sustainability of urban areas. It's also harmful to human health.

AVOID



Unshielded, white LEDs, Central Park, NYC. Image source unknown.



Unshielded, white LEDs Central Park. Image Tom Harradine.



Hagley Park, Christchurch. Image Kyra Xavia.



Image source unknown.



Image source unknown.

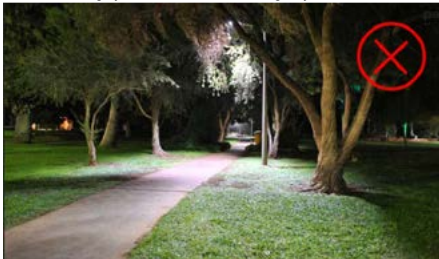


Image source unknown.



Greenmount Headland Pathway, Gold Coast. Image ADLT Lighting.



Image ADLT Lighting.

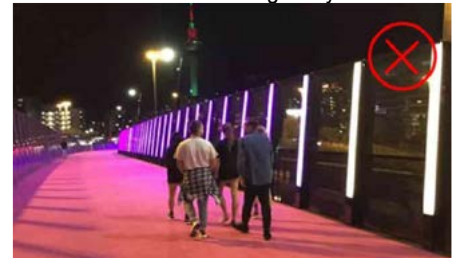
Below left, although the top shielding is good, white light is inappropriate. Below right, this lighting could have been more thoughtfully executed.



Image Louis Poulsen.



Shropshire National Commuter Cycleway. Image acrospire.co



Auckland, NZ. Image source unknown.

IMPROVED

Keep lighting close to the ground. If using tall fixtures, ensure they emit well-controlled, evenly dispersed, softly diffused, glare-free, amber light.



Amber LED Bollards. Batts Rock, Barbados. Image Talma Mills Studios.



Ecologically responsible amber lighting. Image outdoorlights.com



NBA LEDs to protect ecology. Image Acuity Brands.

Below centre, soft, low-level, low glare, warm lighting. Below right, controlled, well-directed, soft, warm lighting. Amber would be ideal.



Amber LEDs Driebergen Netherlands Image Shreder Lighting



Mandel Bike Path, Roeselare, West-landers. Image Shreder Lighting.



Image WE-EF Lighting.



Bim'Bimba-Park, Gold Coast, Australia. Image FPOV. www.f-pov.com

Responsible Lighting for Intersections, Pedestrian Crossings, Roadwork Signs and Emergencies

AVOID

Below left, these new flashing LED pedestrian crossings highlight the drawbacks of high-intensity, excessively bright LEDs. Even though the colour is amber, such signs can be a hazard. Counter to their purpose, their intense radiance can hinder visibility and compromise safety and their intense flashing can be problematic. Below right, high contrast white LEDs, with the backlit LED sign, as well as flashing amber LEDs may decrease safety. This inappropriate lighting may also be discriminatory against mature drivers and those who are light disabled.



Flashing LED Pedestrian Crossing Sign. Image trafficsafetyzone.com



Flashing LED Pedestrian Crossing. Image Tapconet.com



Flashing LED Pedestrian Crossing. Image Bercman.com

Below left, the same kind of crossing as above right, but in hazy weather, highlights how unfit-for-purpose white LED lighting is. The shorter blue wavelengths of light bounce off water particles increasing glare, and the excess contrast can make it difficult to see objects in the shadows. The illuminated square signs also flash brightly. Below centre, another example of unfit-for-purpose LED pedestrian crossing lighting. This photo has been taken side on because the extreme glare it emits makes it impractical to photograph directly. Below right, the same crossing from a distance.



Flashing LED Pedestrian Crossing. Image Bercman.com



Image Howard Industries. www.pedestriancrosswalk.com



Flashing Pedestrian Crossing Signal. Image www.howardindustries.com

Below, bright LED strips, called "Zombie Lights" in Bodegraven, Netherlands installed in an attempt to signal pedestrians too busy looking at their smartphones, to look up. While well intended, this approach introduces more uncontrolled, unnecessary, high-intensity, vividly coloured light. If LED lighting technology is used, its excess radiance, non-uniform light distribution, flicker, etc, need to be adequately resolved.



Image www.thetimes.co.uk



Tel Aviv, Israel. Image Sebastian Scheiner/AP

Below, although amber light is better than harsh white light, the flashing, high-intensity LEDs with exposed diodes make these signs unsafe.



Image alibaba.com

IMPROVED

It's best to keep using the well recognised, covered, orange globes that mark pedestrian crossing as shown below, and to use reflective signs. They turn on and off at a safe rate without triggering epileptic seizures, and they are less distracting, and safer for pedestrian crossings.



Effective, safe, pedestrian lighting. Images simmons signs.co.uk

Below left, safer yellow globe lighting on a traditional pedestrian crossing with an automated strip of red LEDs inset into the road itself which light up when a pedestrian is about to cross. This is an acceptable approach, as long as the LEDs have diffusing optics so the diodes have diffusing optics so they are NOT exposed.



Automated red LED strip. Image Direct Line. www.thisismoney.co.uk



Close up of LED strip with exposed LED diodes. Image Direct Line.

Emergency Lighting

Emergency LED strobe lights used on police vehicles, fire trucks, ambulances, and other vehicles can be problematic due to the existing drawbacks of the technology. They can seriously degrade an already hazardous situation by reducing visibility^{98,99} and they may be an unnecessary stressor in an already stressful situation. It's important to note that recent research found lower intensity lights remained highly visible. The authors recommend using lower intensities at night will reduce discomfort glare without reducing the lights' visibility. This indicates stationary vehicles in nighttime blocking mode should be sufficiently visible with lower intensity lights. Furthermore, the study raises the possibility that combining high intensity lights with high visibility markings may make it more difficult for drivers to see responders on foot at night, even when the responders wear high visibility vests. This research indicates that high-intensity LEDs significantly degrade visibility. Additionally, yellow and red lights were the least glaring which suggests that low-intensity, red lights for stationary blocking operations may offer the best combination of better visibility with less glare.

Flashing lights are also well known to trigger epileptic seizures and migraines, and they can incapacitate light sensitive and vulnerable individuals making them ill for weeks. Reducing the number of flashing lights is helpful, as is using effective barrier signs and traffic cones. Below, note the strong contrast, extreme glare and dense shadows, all of which compromise visibility and safety.

AVOID



Image nj.com

98 - LED Study: To Protect First Responders, Brighter isn't Better. March 2022. <https://coffeordie.com/emergency-responder-safety>

99 - [New Study of Driver Perception of Emergency Warning Lights and Retroreflective Markings Commissioned by The Emergency Responder Safety Institute Yields Surprising Findings](#). March 2022.

Responsible Lighting for Swimming Pools / Hot Springs

AVOID

Water reflects and absorbs light so minimise lighting as much as possible. Illuminated water also acts as an ecological trap, attracting insects and birds, harming the ecosystem. Avoid vivid colours, overlighting, light clutter, and high-intensity (bright) lighting, and lighting up foliage and trees.



Image source unknown.



Image source unknown.



Image source unknown.



Image outdoortheme.com.



Image elementaled.com.



Image walmart.com

Below left, avoid glare from poorly executed lighting on the wall. Below centre/right, avoid colourful lighting and lighting on plants (below right).



Image www.srsmith.com



Image www.ebay.com



Image www.designrulz.com

Poorly executed lighting at a public swimming pool (below centre) and hot springs (below right).



Image source unknown.



Image source unknown.



Ourray Hot Springs Colorado, US. Image source unknown.

IMPROVED

Minimise pool illumination as shown below. Use warm amber and keep the lighting levels as low as possible (bottom right). Rather than lighting the water, illuminate around the pool as shown below left. Ideally, avoid pool lighting all together, bottom centre. (Also see images on pg 62).



Image source unknown.



Above centre/right, Mykonos Riviera Hotel and Spa Pool, Mykonos, Greece. Images <https://ledeko.gr/>



Image source unknown.



unxi Town in Yan, Zhangjiakou, Hebei Province, China. Image litawards.com.



Atlantic Beach, Florida, US. Image outdoorlights.com

Responsible Street Lighting

White LED street lights are unfit-for-purpose and their energy efficiency has been grossly exaggerated. To deliver genuine savings they must be dimmed by at least 50% and their lumen output reduced. Light pollution has increased in the last 10 years by 300% and a major factor is white LED exterior lighting. It's estimated by 2025, 95% of lights globally will be LED, so they must be applied with care and restraint. They should be fully shielded, full cut-off, amber in colour (1600-2200 K), with recessed/hidden diodes/chips/bulbs, and diffusing optics. Note (below right) that although the sky appears dark due to the strong contrast of LEDs, high intensity light forces the pupil to restrict, which prevents the detection of all but the brightest stars. (Contrary to claims made by the lighting industry, white LED street lighting prevents visibility of the night sky.)

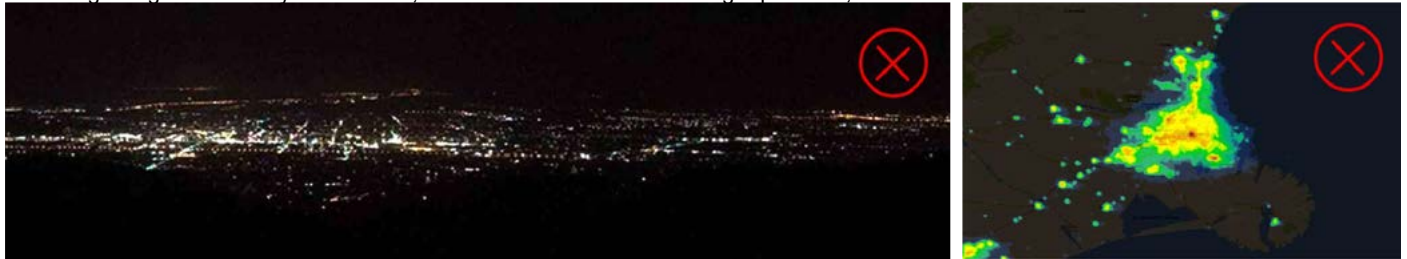
Below left, HPS street lights before the retrofit in Vogel Street, Dunedin. Below right, after the failed LED retrofit.



Although HPS street lights are unshielded, they provide safer lighting than white LEDs.

Unfit-for-purpose, white 4000 K LEDs. Images Dr. Alex Tups.

Below, Christchurch city after the 4000 K LED retrofit, which contrary to claims,¹⁰⁰ has not reduced light pollution. Instead, the retrofit has degraded access to the night sky and introduced inappropriate, biologically/ecologically disruptive white light into the environment. Skyglow above the city on cloudy nights is now white. Below right, an image of light pollution taken from Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership satellite. Despite the fact the VIIRS sensors are relatively insensitive to the wavelengths light emitted by white LEDs, there's been no decrease in light pollution, but a small increase.



Unfit-for-purpose white 4000 K LEDs have dramatically altered the appearance of the city. Image Christchurch Council.

VIIRS satellite image of Christchurch 2021.

A much safer and sustainable course would have involved shielding the former HPS lamps and to dim them. (Contrary to claims, HPS lamps are not being phased out, and they can be dimmed.)¹⁰¹ This approach can save energy, will extend the lamps' lifespan, reduces carbon emissions, prevented the unnecessary disposal and waste of functioning light sources, and saves municipalities and rate payers millions of dollars.

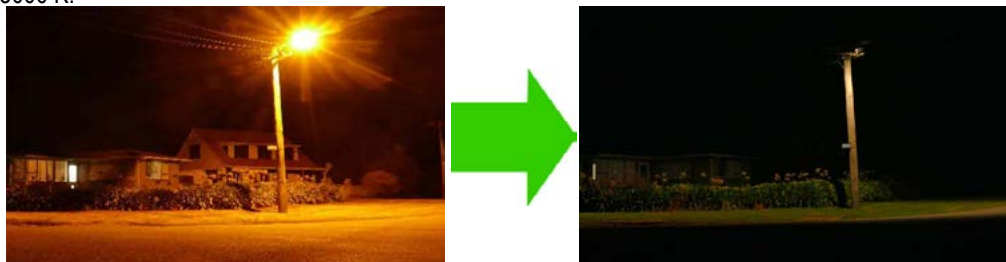
Below, Christchurch city with unshielded, HPS street lights before the LED retrofit.



Unshielded, HPS street lights before the LED retrofit. Image Christchurch Council.

VIIRS satellite image of Christchurch 2016.

Below right, shows why LEDs are unsuited for wide areas of road/streets. The unshielded HPS lamp (below left) has been replaced by a white Sasta 3000 K LED with extra added shielding (below right). Although the white light is inappropriate, shielding dramatically reduces the glare typical of LEDs (as shown in the other examples on the next page). A much better outcome would have been amber 2200 K LEDs with added shielding, instead of 3000 K.



Unshielded HPS Austin Street, Kaikoura, with HPS lamps. Image Larry Field.

Unfit-for-purpose 3000 K Sasta LED with added shielding. Image Larry Field.

100 - Poor misleading reporting by Stuff. March 2022. <https://www.stuff.co.nz/environment/127901527/then-vs-now-photos-show-how-much-led-lights-have-changed-christchurchs-nightscape>
101 - Dimming for high-pressure sodium lamps. <https://dimmlight.de>

AVOID

Below, unfit-for-purpose, harsh, glary, high-intensity, high contrast, white 4000 K LEDs. Below centre, note that the bright reflections on the surface of the wet road obscures road markings and increases light pollution. Below left/centre, harsh, glary, unfit-for-purpose, white 4000 K LEDs. Note the intense brightness and light trespass/nuisance into residential homes. Below right, good shielding but an unsafe colour and spectrum.



Fendalton, Christchurch. Image Stacy Squires/STUFF.



Main Street, Oamaru. Image Damien McNamara.



Rivara street lights in Arraiolos, Portugal. Image [Schreder Lighting](#).

Below left/centre, unsafe colour and spectrum, glare and obtrusive light trespass, with overlighting. Below right, although the design of the custom-built illuminated columns reduce direct glare, they are still too bright, the white light is also inappropriate, and there's too much light.



Unfit-for-purpose LEDs, Oamaru, NZ. Image Damien McNamara.



Street lights/illuminated poles. City Walk, Dubai. Image [Ligman Lighting](#).



Blinding, harsh, unsafe LED street lights. Image source unknown.

Below left, note the extreme glare on the road from one unfit-for-purpose 3000 K LED, which obscures road markings and worsens driving conditions, compared to the older HPS lamps in the same image. Below centre, unhappy residents gather beneath the new LEDs in Palmerston North which degraded lighting conditions instead of improving them. Below right, glare on the road from unfit-for-purpose 4000 K Oamaru, NZ.



Harsh, glary, white 3000 K LED Dunedin, NZ. Image Paul Le Comte.



Failed LED retrofit Palmerston North, NZ. Image source unknown..



Failed LED retrofit Oamaru, NZ. Image Damien McNamara.

Below left, unfit-for-purpose, white LEDs in Braganza, Portugal, contrasted beside safer, less disruptive, orange HPS lamps. Below centre, unfit-for-purpose LEDs near water beside Brandenburg Salzufer and St Johanniskirche, Brandenburg an der Havel, Brandenburg, Germany. Below right, an empty street in Oak City, Utah with high levels of inappropriate, white LED street lighting.



Image [jornalmaisbraganca.com.br](#)



Image Lutz Dörpmund.



Oak City, Utah, US. Image [Cree Lighting](#).

Below left, harsh, glary white LED street lighting in Anchorage, Alaska. This type of lighting is particularly ill suited for areas with snow fall as the scattering effects of shorter blue wavelengths increase light pollution. Below centre, inappropriate uncontrolled white lighting that shines directly upwards. This is unsuited for this narrow and historic walkway.



Anchorage, Alaska, Image [Cree Lighting](#).



Image source unknown.

Responsible Street Lighting

IMPROVED

If LEDs are installed they need to be fully-shielded, full cut-off, amber LEDs like in the example below. Ideally they also have diffusing optics.



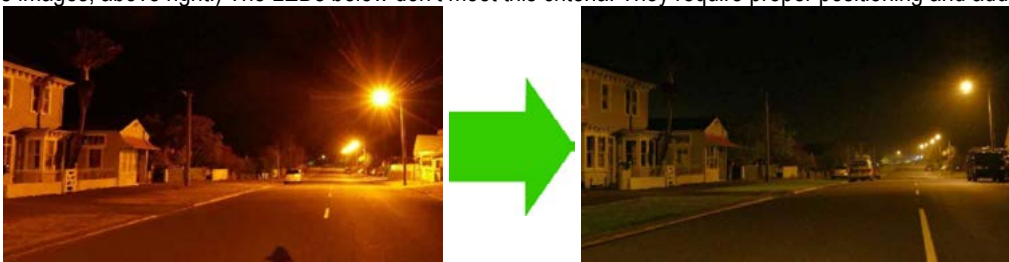
Sherbrooke, Québec, Canada, within the Québec, [Mont-Mégantic International Dark Sky Reserve](#). Image Rémi Boucher.

Below left, unfit-for-purpose, 4000 K white LEDs. Below right, replaced with fully shielded, full cut-off, amber 2200 K LEDs.



Silges, Nußtal, Germany. Images Sabine Frank.

Below right, highlights how important it is to dim LEDs. Betacom GL520 Amber 2200 K LEDs have been dimmed by 75% down to 25%. What's more, with properly designed and correctly positioned and angled LEDs, the light sources should not be visible from a distance (or from above). (Compare this to the images, above right.) The LEDs below don't meet this criteria. They require proper positioning and added shielding.



Before the retrofit. Unshielded, HPS lamps Torquay Street, Kaikoura. Image Larry Field.

After the LED retrofit. Dimmed down to 25%. Image Larry Field.

Below left, an unfit-for-purpose, harsh, glary, 4000 K white LED. Note the hot spot of white light directly underneath the white LED and the dark area of shadow just beyond it showing the poor uniformity and strong contrast of most LED street lights. They have been replaced with more appropriate amber 2200 K LEDs which have been dimmed down by 75% to run at 25%. This is an improvement, however shielding is needed to further reduce glare and light trespass and improve visual comfort. (Keep in mind LED lighting like this is not an improvement to the HPS due to it's many drawbacks.)



Before the retrofit. Harsh glary 3000 K LED. Kaikoura. Image Larry Field.

After the LED retrofit. Dimmed down to 25%. Image Larry Field.

Before the retrofit. Unshielded, HPS lamps Torquay Street, Kaikoura. Image Larry Field.

After the LED retrofit. Dimmed down to 25%. Image Larry Field.

IMPROVED

Fully shielded, full cut-off, amber LEDs that emit light which assists visibility at night are a better option than harsh, glary, white 3000-4000 K LEDs, which disrupt circadian health and adversely impact ecology. Below left, ecologically responsible, shielded LEDs to protect loggerhead sea turtles and wildlife. This lighting is also beneficial to human health. Below centre/right amber 1800 K LEDs. Diffusing optics would further reduce glare.



Treasure Island, Pinellas County, Florida. Image Catherine Hawley.



Amber LEDs, La Patrie, Mont-Mégantic Dark Sky Reserve, Québec.



PC Amber LEDs. Santa Pau, Garrotxa, Spain. Image Ignia Light.



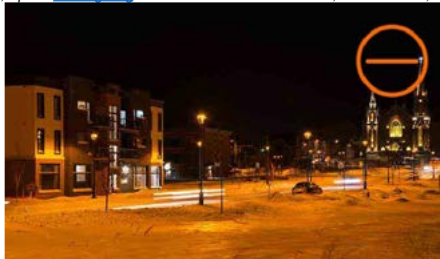
Parque de los Riegos, Noreña, Spain. ATP Lighting.



Artenara, Gran Canaria, Canary Islands. Image Ignia Light.



Santa Maria degli Angeli, Italy. Image Targetti Lighting.



Amber LEDs, Lac Megantic.. Image Mont-Mégantic Dark Sky Reserve .



Amber LEDs. Image Urberdermis Santa & Cole.

Below, adjustable, tunable LED street lights to protect ecology in Lille, France. From April to November, when the bats are most active, only the amber LED modules switch on and off to protect them. Then from November to March, when the bats hibernate, the LED modules with amber and white LEDs (2,200K) switch on and off depending on the time of night and the presence of people.



La Citadelle Park, Lille, France. Images Schreder Lighting.

OPTIMAL

In 2012, the Street Lighting Energy Reduction Project was initiated throughout the UK, and numerous counties began to turn off their street lighting during off-peak hours (between midnight and 5:30 am) to save money and energy, and reduce carbon emissions and maintenance costs. Due to its success, this continues today in many places including North Yorkshire, even with those places that have had LED retrofits. Below left, the A692, near The Grove, Durham, UK. Dec 2014.



The A692, near The Grove, Durham, UK. Dec 2014. Image www.chroniclive.co.uk

Responsible LED Heritage Lighting

Heritage lighting needs particular care because the design of older style lamps did not consider the impact of a ALAN and light pollution. Most modern heritage light sources require thoughtful redesigning to control and mitigate the unique properties of LED lighting technology. Acorn style lamps and luminaires with clear glass housing can be inappropriate as this type of lighting can cause light pollution, light trespass, glare and visual discomfort. Not only is the white light excessively bright and an unsafe colour/spectrum, the whole purpose of heritage lighting is to respect the ambience and aesthetics of historic settings and for lighting to be complementary. It makes no sense to use heritage fittings that emit cold, harsh, intensely bright and glary, white lighting, when the original light sources emitted a warm, soft, welcoming, gentle glow.

AVOID

Below left, the fixtures emit uncontrolled, harsh, glary, white light that's light polluting, inappropriate, unsafe and harmful to health. Below centre, although the acorn-style fixtures have a top shield, they still emit too much uncontrolled, unsafe and inappropriate, harsh, bright, white light. Below right, harsh, bright, white light that is too strong in contrast. This produces hot spots of brightness and dense pools of darkness which hinder visibility and compromise safety. It also makes the street area appear cold, stark and unwelcoming.



Papiermolensluis Brouwersgracht, Amsterdam. Image wallhere.com



Image source unknown.



Image Zeta LED Lighting UK

Below left, in 2017, there was public outcry in Rome about the harsh, glary, cold lighting from the LED retrofit ruining the ambience of the city.¹⁰² Below centre, harsh, bright, white lighting in Central Park that can disrupt human health, compromise safety, and harm the precious biodiversity of ecology that exists in one of the most important green areas the city. Below right, uncontrolled, harsh, glary, white LEDs in Amsterdam. This is insensitive to the historic architecture, cultural heritage and aesthetic appearance of the city, plus it's inappropriate near water as the reflections of white light can increase light pollution.



Image Gianni Cipriano/New York Times/Redux/eyevine



White LEDs Central Park, NYC. Image www.flickr.com/photos/nilspix



Image source unknown

Below left, although shielded, there's still unacceptable light trespass into residents windows, the white light is inappropriate and disruptive to health, and the diodes are exposed which causes glare, as revealed from ground level, below centre.



Heritage LED Lighting, Frosinone, Italy. Image Cree Lighting.



Heritage LED Lighting, Frosinone, Italy. Image Cree Lighting .



Image Annette Krop-Benesch

Below left, inappropriate, white LED lighting in the historic city of Florence, Italy, that is insensitive to its cultural heritage and architecture.¹⁰³ Furthermore,, instead of reducing light pollution, the 4000 K LED retrofit in Florence resulted in the city keeping their street lights on all night instead of the previous policy where they were turned off at 11:15 pm at night. Below centre, LEDs with optics to improve visual comfort, but they're on tall poles, they emit disruptive white light, and they're too close to the water. Below right, although the diodes/bulb are covered by a frosted cover, the white light is inappropriate and insensitive to the historic building and setting.



Image aecilluminazione.com



Image aecilluminazione.com



Eglise de Marly, Fribourg, Switzerland. Image RD Light le Mouret.

¹⁰² - Streetlight fight in Rome: Golden Glow vs. Harsh LED. March 2017. <https://www.nytimes.com/2017/03/27/world/europe/rome-streetlights-led-lights.html>

¹⁰³ - Historic Urban Settings, LED Illumination and its Impact on Nighttime Perception, Visual Appearance, and Cultural Heritage Identity. October 2018. https://www.researchgate.net/publication/328809838_Historic_Urban_Settings_LED_Illumination_and_its_Impact_on_Nighttime_Perception_Visual_Appearance_and_Cultural_Heritage_Identity

Below left, poorly executed heritage lighting in Braganza, Portugal. It's insensitive to the historic setting and architecture, ruining the ambience of the warmer lighting. It's also inappropriate for parks. Below centre, view of the white LED lighting in the city of Braganza contrasted with the safer, more complimentary, warm, orange HPS that illuminates the castle walls.



Image [Smart Lighting](#).



Image [armadaled.org](#)

In 2014, the 1970's lighting on the Columbia Wrightsville Veteran Memorial Bridge in Pennsylvania, was replaced with replica historic fixtures. This resulted in the attraction of millions of mayflies between late June and early August each year. The lighting lures newly emerged adults away from their natural habitat on the water to a futile death before breeding. Also, the light reflecting off the surface of the road and pavement tricks others to lay their eggs on the bridge instead of the water. As mayflies control algae growth and are food for fish, this manmade interference may alter ecosystems. Below left, inappropriate, glary, harsh, white, heritage lighting. Below centre, close up of the drop acorn design of the light fixtures with dead mayflies underneath. (The city has considered adding lighting underneath, following the poor example (below right) however, this is not an acceptable solution. Lighting must be minimised, it needs to be a safer spectrum, shielded, controlled and directed only to where it's needed - which is low to the ground on the bridge itself. Dimming would also help.) This situation illustrates just how important it is to do an environmental impact report before making significant changes to lighting and to carefully illuminate bridges to minimise adverse impacts on ecology. (Some situations may not warrant installing heritage fittings.)



Veterans Memorial Bridge, Pennsylvania. Image [Blaine Shahan](#).



Image source unknown



Harrisburg City Market Street Bridge, Pennsylvania. Image source unknown.

IMPROVED

Below left, 2700 K LEDs with frosted glass and metal lattice housing. Light is diffused for visual comfort. The warm light also suits the historic setting. Below centre/right, well-directed, low levels of warm lighting reduces light pollution, complements the architecture, is less disruptive to human health and ecology, and is far less light polluting. Below right, well-directed, shielded lighting. Ideally, the colour should be warmer.



Saint Cirq Lapopie, Dordogne Valley, France. Image [Schreder Lighting](#).



Sassoferrato, Italy. Image [Neri Lighting](#).



Baia Sistiana, Italy. Image [Neri Lighting](#).

Below left, HPS sodium heritage lamps are safer and emit softer, less harmful and disruptive light than amber LEDs. Below right, an appropriate



Brandenburg an der Havel, Germany. Image [Annette Krop-Benesch](#).



Najac, France. Image [Patrice Nin/Comatelec](#). [Jean Marc Charles](#).

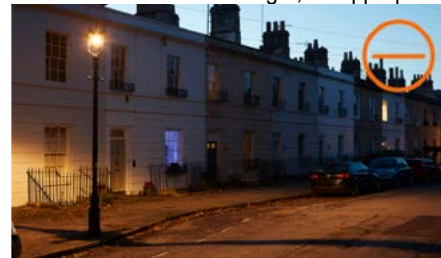


Image [Crossroads Lighting](#).



Image [Crossroads Lighting](#).

Responsible Lighting for Marinas

Keep lighting shielded, well-controlled, warm in colour and spectrum, and close to the ground. Also avoid light clutter. It's important to carefully restrict lighting to illuminate the boardwalk itself, NOT the water. This can be achieved by placing shielded light sources on the inner side of low posts so the majority of light is directed to the boardwalk. It's critical to avoid underwater lighting beneath docks.

AVOID

Below left, although this LED light source has optics to lower glare, the lighting levels are still too high, and the fitting is on tall poles which means more disruptive, light polluting light reaches the water. (White light is highly inappropriate this close to the sea.) Below centre, blinding, harsh, white LED lighting in the small town of Kaikoura. Below right, observe the unnecessary light spill on/into the water.

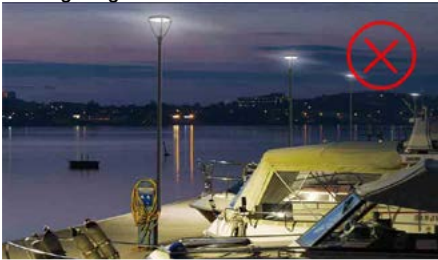


Image www.aecilluminazone.com



Blinding white LED, South Bay Marina, Kaikoura. Image Kyra Xavia



Unshielded, white LED solar lighting. Image lakelites.com

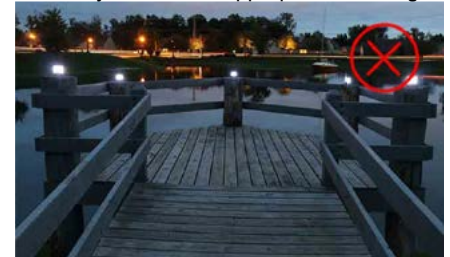
Below left, although the LEDs are placed low, they're unshielded, too bright, too white, and they lack optics to mitigate glare. Below centre, unshielded, poorly controlled, white LED lighting. Below right, although these LEDs are less glary because the diodes are covered with a frosted material, more appropriate fittings could have been used so the light sources themselves are not visible. They also emit inappropriate white light.



Unshielded, glary, white LED solar lighting. Image lakelites.com



Unshielded, glary, white LED solar lighting. Image lakelites.com



Unshielded, covered, white LED solar lighting. Image lakelites.com



Inappropriate underwater dock lighting. Image alternativeoffroad.com

Below, although the colour and spectrum is an improvement, there are too many light sources (light clutter). They're also unshielded and poorly positioned so the lighting is uncontrolled. (Note the light reflections on the water.) Also, it's best to have light sources with hidden/recessed chips/diodes/bulbs, as shown in the three images at the bottom of this page.



Image source unknown.

IMPROVED

Below left/centre/right, lighting is warm, well-controlled, indirect, glare-free, and only illuminates the area that's needed. Ideally, the colour and spectrum would be even warmer (1600-1800 K).



Amber solar cleat lights. Image lakelites.com



Amber Capped Dock Lights. Image synergylighting.usa.com



Image dockgearsupply.com

Responsible Lighting for Fountain and Water Features

The illumination of water should be avoided for numerous reasons explained earlier in this document. If lighting is necessary, please apply the following guidelines. Also, ensure it's operated by timers to switch off automatically at 11 pm in summer and 10 pm in winter.

AVOID

Avoid white and vividly coloured, high-intensity lighting that's excessively bright, as shown below. Also avoid leaving lighting on all night.



Image Roy Harryman at Pixabay.



Water fountain on Passeig de Gràcia, Barcelona. Image [lgnialight](#).



Image LoggaWiggler at Pixabay.

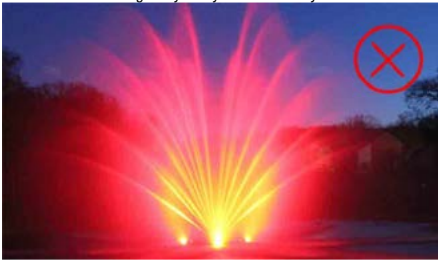


Image source unknown.



Image meinerestampe at Pixabay.



Image Tomasz Mikołajczyk at Pixabay.

IMPROVED

Keep lighting as subtle and low key as possible. Use low lighting levels and choose warm coloured light sources with an automated timer so lighting is on for only a few hours at night.



Image Mackay Landscape Lighting Inc, Omaha, Nebraska.



Water fountain on Passeig de Gràcia, Barcelona. Image [lgnialight](#).



Amber-Water-Fountain-Image Atlantic Water Gardens Services.



Image Pinterest.com

Responsible Exterior Lighting for Vehicle / Car Sale Yards

Most often, vehicle/car sale yards have poorly executed lighting that is an inappropriate colour and spectrum, is unshielded, poorly directed, harsh, glare, and too bright. It's also common for lights to be left on all night which is unnecessary. It's far more effective to have lighting that automatically switches off at a set time (11 pm in summer and 10 pm in winter) which is activated by sensors from activity. The image below right, shows well shielded lighting on the building (an improvement), however, it's still too bright and it's an inappropriate colour and spectrum.

AVOID



Image Autotraders.com



Image oldlenses.blogspot.com



Image source unknown.

IMPROVED

Use low levels of light that's shielded, well-directed, glare-free, and warm, set by timers to switch off at 10pm in winter and 11 pm in summer, and automatically activates from activity. Below, note the effective, shielded, warm, amber 2200 K LED wall packs that direct light downwards.



Audi car dealership, Sherbrooke, Québec, Canada. Images [Megantic Dark Sky Org](http://MeganticDarkSkyOrg)



Motorcycle Dealership Sherbrooke, Québec, Canada. Image [Megantic Dark Sky Org](http://MeganticDarkSkyOrg).

Responsible Lighting for Service Stations

It's all too common for service stations to have poorly executed lighting that is unshielded, poorly directed, harsh, glare, and too bright, with an inappropriate colour and spectrum. It's also common for lights to be left on all night which is unnecessary. Note the light clutter, intensity, white light, glare, over lighting, and no shielding in the image below left, as well as the inappropriate colour and spectrum, as well as the overlighting in the images below centre/right. Some service stations are worse offenders due to the colour way of their branding. White, blue and green for instance, can be more disruptive than red and orange, but even red and orange can be problematic when they're too bright.

AVOID



Image Donny Jiang Obh unsplash.com



Image source unknown.



Image pxhere.com

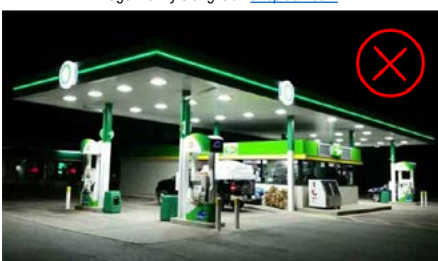


Image www.pavinclauss.com

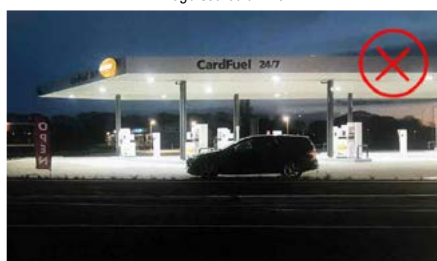


Image Mckeown Service Station.



Image NPD Self Service Station Kaikoura. Image Larry Field.

Responsible Lighting for Service Stations

IMPROVED

A study found when the lighting was changed from high glare fixtures (below left) to full cut-off (below right) the percentage of drivers turning into the station and the volume of fuel sold daily increased immediately, suggesting drivers find quality lighting more appealing.¹⁰⁴ Ideally, the lighting in the below right photo, would also be warmer in colour and spectrum.



Below, reasonable light levels can be achieved to provide visibility, safety, and comfort.



Shell Station, Sherbrooke, Québec, Mont-Mégantic International Dark Sky Reserve. Images [Megantic Dark Sky Org.](https://www.meganticdarksky.org/)

Below, note the subtle signage on the side of the canopy, and most importantly, the low levels of lighting underneath.



Express Stop Gas Station, Flagstaff, Arizona: the world's first dark sky city. Image source unknown.

Below left, shows lower levels of lighting. Further improvements could be made with warmer coloured lights and shielding. Below right, soft, warm lighting with low lighting levels. Note there's no harsh drop off into dense shadow, as typically seen with white LED lighting. This highlights how strong contrasting LED lighting hinders visibility, whereas the softly illuminated spaces below right, supports visibility and navigation.



Image BP.



Image <http://cyclinghome.nu-p=2986>

Shielding for Service Station Canopy Lighting

For canopy lighting it's helpful to add shielding (as shown below left/centre). Ideally, shielding is on ALL four sides of the light fixture. This should be standard until improved LED light sources are available that don't require such measures. This reduces light pollution, provides visual comfort, and reduces adverse impacts on wildlife. In Kaikoura, full shielding, the lowering of light output, and the use of amber light (1600-2200 K) is essential to help reduce the fallout of endangered Huttons Shearwaters and other vulnerable species.



Added shielding at the NPD Self Service Station, Kaikoura. While this is a helpful step, the intensity of light still needs to be lowered and the colour changed to amber. Images Kyra Xavia./ Larry Field.

104 - Courtesy Rensselaer Polytechnic Institute. <https://skyandtelescope.org/astronomy-resources/bright-lights-bigproblems/>

Responsible Service Station Signage

AVOID

Below left, while the canopy lighting is more appropriate, the bright self-illuminated sign is problematic, as are the other two examples.



Image BP.



Image courtesy Anthony92931, Wikimedia Commons.



Image McKeown Service Station.

Responsible Lighting for Retail Outlets, Signage, Advertising, and Self-illuminated Billboards and Displays

Self-illuminated billboards and signage cause light pollution, light trespass, they're an environmental stressor, a distraction and hazard for drivers and pedestrians, and a health risk to residents.^{105,106} Waka Kotahi (NZ Transport Agency) recognises international evidence that digital advertising billboards distract drivers more than conventional static billboards, particularly on high-speed routes, and latest figures in NZ record distraction as a factor in 23 roads deaths and 125 serious injuries in 2020. The Automobile Association urged motorists not to be distracted by the bright lights in plain view or out the corner of the eye, as a key advertising medium gains even more prominence on Christchurch's landscape.¹⁰⁷ It's best to restrict illuminated advertising to certain built up zones in cities, and to turn it off after 11 pm. Due to the excessive brightness of LED technology changing lighting levels, and limitations of existing luminance measuring devices, it's not possible to accurately gauge the amount of light that's emitted from digital billboards and self illuminated displays.^{108,109} Communities that value the safety, health, well-being, and life quality of residents, as well as the importance of protecting wildlife and the night sky, need to restrict or completely avoid this kind of illumination, especially displays that emit high intensity, white and/or blue, and vividly coloured light.

AVOID

Below left/centre, light polluting, health disrupting, bright, white advertising in shop windows. Below right, excessively bright, white signage.



Image source unknown.



Image source unknown.



Samyan Mitrtown Mall, Bangkok. Image [Ligman Lighting](#).

Below, illuminated advertising at bus tops is unnecessary and adds excess light into the environment.



Image source unknown.

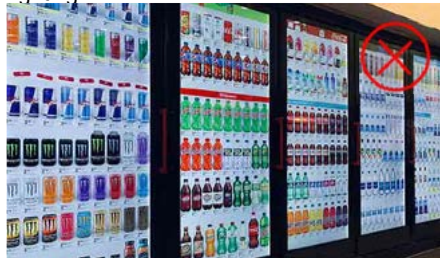


Image [www.architonic.com](#)



Image [www.cnyeroo.en.made-in-china.com/](#)

Responsible lighting also extends to fridge and food dispensers, especially when they are placed outside. Below left/centre, the unnecessary introduction of illuminated digital screen doors, instead of clear glass. The sole purpose of these screens is to expose customers to more intense advertising. Not only do these screens expose people to more artificial light, they can be particularly problematic for people who are light disabled and cannot tolerate LED lighting.



Images Cooler Screens.

Please note that awareness about the impact of LED lighting has been acknowledged by the supermarket chain Countdown here in NZ. After a year trial, in October 2019, it launched 'autism-friendly' quiet hour once a week nationwide, where outlets switch off their lights and turn down the music.¹¹⁰ "The majority of lights in the roof and the in-store radio are turned off, the "beep beep" sounds on the checkouts are muted and there are no announcements over the loudspeaker - except in emergencies." Autism New Zealand say 80,000 people in the country are affected by autism. For the major supermarket retailer, that justified imposing the quiet hour in all NZ stores (excluding Auckland and Wellington's Metro City branches), where almost every store does the same thing on Wednesdays between 2:30 and 3:30pm. According to an RNZ article, the store employees were also excited for the calm that the initiative brings, Countdown Three Kings Store Manager David Collo said, "You really get to realise how noisy the store really is and **how bright it is, because there's LED lights everywhere and you take it for granted. And when you turn it off it's like, wow.**" Elderly customers also enjoyed the stress-free environment of the quiet hour. "This highlights how some small changes can create a more inclusive environment that will positively impact people significantly." Countdown developed the quiet hour alongside Autism New Zealand, which provided advice on how to best support customers.

105 - Swedish Study Shows Digital Billboards Distract Drivers. July 2012. <https://www.scenic.org/wp-content/uploads/2019/09/eebdd.pdf>

106 - Health Effects of Large LED Screens on Local Residents - January 2013. <https://www.nceh.ca/documents/practice-scenario/health-effects-large-led-screens-local-residents#conclusions>

107 - Authorised digital distractions. March 2022. <https://www.odt.co.nz/star-news/star-christchurch/authorised-digital-distractions-do-billboards-pose-road-safety-risk>

108 - Global Approaches to Reduce Light Pollution from Media Architecture and Non-Static, Self-Luminous LED Displays for Mixed-Use Urban Developments. April 2019. <https://www.mdpi.com/2071-1050/11/12/3446>

109 - A Systematic Review for Establishing Relevant Environmental Parameters for Urban Lighting: Translating Research into Practice. Jan 2022. <https://www.mdpi.com/2071-1050/14/3/1107/html>

110 - Countdown supermarket launches 'autism-friendly' quiet hour nationwide. <https://www.nzherald.co.nz/lifestyle/countdown-supermarket-launches-autism-friendly-quiet-hour-nationwide/6L67SATC477MZQEQGQZKFYZ4A/>

IMPROVED

Ideally, signage is lit with shielded downlights and the surface is matt. If using illuminated signage, choose a warm colour as shown below right. Backlit signage is also a good option, especially if it's warm in colour (second row centre/right).



Image sources unknown



Image source unknown



Image source unknown



Image KWKCHINA Store Aliexpress.com



Image [Ligman Lighting](#).

Responsible Architectural, Facade and Media Architecture Lighting

Urban environments have become significantly brighter and more illuminated, and cities now consider media architecture and non-static, self-luminous LED displays an essential element of their strategy to attract residents, visitors, and tourists in the hours after dark. Unfortunately, most often, they are not designed with care, consideration and awareness, nor do they support the visual wellbeing and circadian rhythms of humans. They also increase light pollution which has an adverse effect on the environment. It's crucial to weigh up the negative impact of facade and media architecture and to consider if extra lighting is even needed. Such lighting needs to be restricted to built environments (A4 Zone - High district brightness). (Refer to <https://www.standards.govt.nz/shop/asnzs-42822019/>). Curfews are best applied so this lighting is off between 11 pm - 6am in Summer and 10 pm - 7 am in Winter.

AVOID

Avoid overlighting, using white, blue and vividly coloured light.



Image eekenya.com



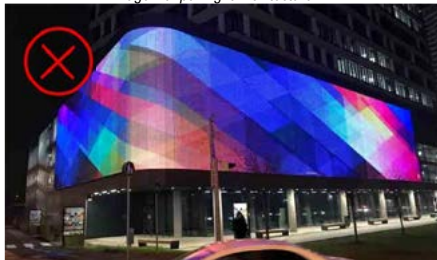
Image Danpal Light Architecture.



....Arc Cinema, Beeston, Nottinghamshire. Image Leonard-Design



Klubhaus St Pauli, Hamburg. led.at Image Markus Pavlowsky.



JTRE, Panorama City III, Bratislava, Slovakia. Image adobols.sk



South China Mall, Dongguan, China. Image hondellighting.com



Image Danpal Light Architecture.



Image Danpal Light Architecture.

IMPROVED

Favour subtle, refined and elegant lighting schemes. Less is more. Lighting needs to be well-controlled, shielded, indirect, warm, evenly distributed, softly dispersed and kept at low levels.



Majadas Once, Guatemala. Image-grupodarcon.com



t Wallefje Business Complex, Belgium. Image DW Windsor Lighting.



Jewish Museum, Berlin, Germany. Image Denis Esakov.

Improved Lighting for Building Complexes, Public Spaces, Seating and Amenities

There's much misunderstanding about lighting and public safety. The six images below show overly bright, poorly executed lighting with high levels of inappropriate, health disrupting, white light at night. It's ill-suited for parks, recreational areas, public seating/ spaces, especially near water.

AVOID



Hamilton Transport Centre, Hamilton, NZ. Image [Ligman Lighting](#).



Bus Station, Poppenbüttel, Hamburg. Image-[www.archimages.de](#)



Oslo, Norway. Image Dana Andreea Gheorghe [unsplash.com](#)



Albero "Light Trees" at the Kristalkule Complex, Turkey. Image [|Guzzini](#).



Eclairage Cimetière Marly, Fribourg, Switzerland. - Image [RD Light Le Mouret](#).



Image source unknown.

IMPROVED

It's more effective to provide illumination that is warm, indirect, softly dispersed, and evenly distributed, as shown in the numerous images below. Lighting levels are kept low and the light sources are hidden from view so there is no glare and discomfort. This offers provides a welcoming, appealing and pleasant ambience that encourages people to stay and enjoy. It's also a safer environment that's easy to navigate.



Bollards PSY400. Image [WE-EF Lighting](#).



Drue Point, Margate, Tasmania. [WE-EF Lighting](#). Image [Michael-O'Keefe](#).



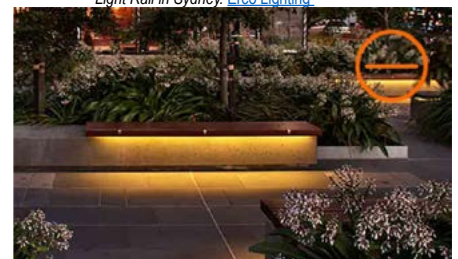
Light Rail in Sydney, [Erco Lighting](#).



Image [Loius Poulsen](#).



Image [archiproducts.com](#)

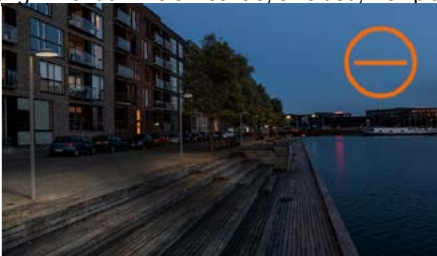


North Wharf & Silo Park, Auckland. Image [Wraight + Associates](#).

Below left, well executed, subtle and effective lighting in London. Below centre, shielded, well-placed, low intensity lighting near water.



St Pauls Vista, London. Image [DW Windsow Lighting](#).



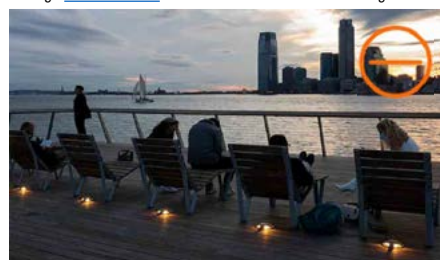
Garcia Sanabria Park, Tenerife, Spain. Image [urbidermis.com](#)



Image source unknown. .



Oath Hill Park, Shizuoka, Japan. Image [Kawasumi - Kobayashi Kenji Photograph Office](#).



Pier 26, NYC. [Linaea Tillet Lighting Design](#). Image [Elizabeth Felicella](#)

Responsible Airport Lighting

AVOID

Below left shows a trial of white LEDs at Munich Airport contrasted beside the older, shielded, lighting. The new LEDs are not an improvement for many reasons, however, this is what airports all around the world are installing. Below centre, LED lighting at Quito International Airport, South America. Below right, Harsh white lighting at Fiumicino Airport, Rome, Italy. Note how the white light (which contains shorter blue wavelengths) scatters more readily in misty air, which increases light pollution. This effect is also obvious in the image, below left).



Munich Airport, Germany, 2014. Image www.ledsmagazine.com



Image Airport Suppliers.



Image Airport Suppliers .

IMPROVED

Below left, Tucson International Airport, General Aviation Apron, Tucson, Arizona. Below centre/right, Leicester, UK.



Image Monrad Engineering Inc.



Midlands Airport Apron, Leicester, UK. Image Matt Short.



Midlands Airport, Leicester, UK. Image Matt Short

Below left/centre airport apron upgrade (tarmac area) Dunedin, NZ. Below right, warm shielded well-controlled lighting Munich. Below left/centre/right, note there is no upward light spill and lighting levels are not excessive.



Dunedin Airport. Image Energylight.



Dunedin Airport. Image Energylight.



Munich Airport Apron 2010. Image Mark (URL - flic.kr/m/arkusnl)

Improved Exterior Lighting for Fire Stations

Although the large glass doors allow light to escape, please note the exterior lighting. Two shielded wall mounts direct light downwards to where it's needed. Furthermore, the use of well-fitted curtains for the windows on the first and second floors will also cut down on light pollution.



Image source unknown.

Responsible Port Lighting

Avoid unshielded, poorly controlled, horizontal, direct, high-intensity, harsh, glary, white lighting (4000-6000 K). Reduce the lumen output to keep lighting levels comfortable and safe. Warm white lighting (2700 K) is safe, effective and more appropriate.

AVOID

Below left, extreme light pollution from Lyttelton Port, Christchurch, NZ, viewed from Governors Bay.



Image Peter Barnett nzpeterb Flickr.com.

There are no photographic examples of improved lighting in this document because none could be found as yet.

Responsible Agricultural Lighting

Vast, artificially illuminated greenhouses are a major source of light pollution as shown below.

AVOID



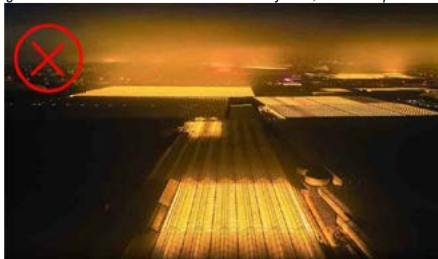
Leamington, Ontario. Image Matt McIntosh.



Frydlant, Czech Republic. Image AP Photo Petr David Josek.



Greenhouses, Netherlands. Images Tom Hegen. tomhegen.com



Greenhouses, Netherlands. Images Tom Hegen. tomhegen.com



Image inui.co.uk

Below left/centre/right, shows the harsh, blinding, excess radiance of LEDs on farm vehicles, and the disruptive white light they emit, which is now a common light pollutant generated from the agricultural sector.



Image jwspeaker.com



Image source unknown.



Image blog.machinefinder.com



Close up of exposed LED Headlights. Image blog.machinefinder.com

IMPROVED

Below left/centre/right, farming vehicles with halogen lamps. These light sources are much softer and safer for the eyes, and less disruptive to ecology, the environment and nightscape. Contrary to what the lighting industry claims (factoring in all the drawbacks, risks, impacts and delivery of light) this kind of illumination is superior to LED lighting technology.



Image Pinterest.com



Image Anthony Reed.



Image thewoodgraincottage.com

Responsible Industrial Lighting

Avoid unshielded, poorly controlled, horizontal, direct, high-intensity, harsh, glary, white lighting. Reduce the lumen output to keep lighting levels comfortable and safe.

AVOID



Image H Yoyogi unsplash.com



MV Oil Refinery, Schwechat, Austria. Image Dmitry Anikin unsplash.com



Maasvlakte Europoort, Rotterdam. Image miapartner.com

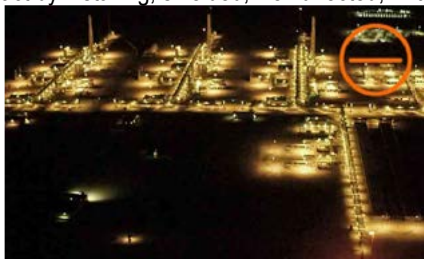
Below, unshielded, high-intensity, white LED lights that are left on all night cause unnecessary and significant skyglow, circled in red.



Light Pollution from Mainland Poultry, Waikouaiti. Image Stefan Mutch

IMPROVED

Ensure all lighting is fully shielded with recessed diodes/chips/bulbs are fully recessed. Control lighting carefully to only illuminate what's needed. Direct light downwards. Choose 2700 K. Below, although industrial plants usually produce light pollution, both complexes have significantly reduced their negative impact by installing, shielded, well-directed, 2700 K LEDs.



Altus Midstream Diamond Cryogenic Complex, Balmorhea Texas.



Apache/Altus Midstream Tank Battery, Reeves County, Texas.

Images [Bill Wren](https://www.bilwren.com), [McDonald Observatory](https://www.mcdonaldobservatory.com).

Responsible Lighting for Events, Matariki, Xmas/Holidays, Decoration and Illuminated Drones

LED lighting now makes it possible to cheaply light spaces with novel, bright, vividly coloured and dynamic lighting, and it's now becoming a common practice to illuminate landmarks with bright colours to celebrate certain anniversaries and/or events. Responsible lighting also needs to extend to the festive season too. Concerns about light pollution, overlighting, tacky, over the top installations for businesses, as well as the popularity of illuminating the streets of residential homes with Christmas lights, has prompted action overseas to tone down this trend in favour of more tasteful, appropriate and responsible lighting.^{111,112} This doesn't mean no lighting at all, rather it involves well executed, thoughtful and appropriate displays. This has many benefits and can be achieved by following the guidelines outlined here.

Matariki

Matariki is now a national NZ holiday, so it's important to acknowledge cultural heritage and the fact darkness is needed to appreciate the stars, especially the small constellation of Matariki. Instead of viewing this time as an opportunity to introduce more artificial light into the environment, Matariki can offer all New Zealanders something unique and important - helping us rediscover our connection to the stars and fostering reverence for natural darkness.

There is growing support for a "lights out" approach where lights are turned off for several hours, so everyone in NZ can see the stars, especially those who live in urban areas. This could become an integral part of nationwide celebrations as it respects with Maori heritage and culture, rather than modern day light festivals/displays/installations, which tend to disconnect us further from the natural rhythms and cycles of nature and our environment.

This approach has been given the full support of Rangi Matamua, NZ's eminent authority on Tataai Arorangi (Maori astronomy). Instead of light displays, we can enjoy the night sky and the nocturnal landscape the way Maori did, before Europeans arrived, and over time, artificial lighting at night became the norm.

For these reasons, if lighting is used to celebrate Matariki, it's best to favour lighting that closely mimics firelight, so it's warm, welcoming, soft, subtle, and pleasant to look at. Most importantly, consider if lighting is even needed.

With this holiday, New Zealanders can learn the value of darkness and gain appreciation for the benefits of nocturnal placemaking.

An effective template developed by Studio Roosegaarde, already exists to help cities and communities around the world turn off their lighting in order to see the stars from their streets. Below, an image of light artist Daan Roosegaarde, looking up at the stars from the urban streets of Franeker, Netherlands, revealed for the first time in decades, via the [SEEING STARS](#) project. (For more information go to pg 63.)



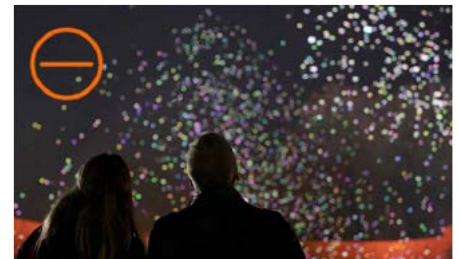
Image [Studio Roosegaarde](#).

Illuminated Drones

Although illuminated drones are replacing fireworks for public events, they have numerous drawbacks including adding more unnecessary, high-intensity light from LEDs into the night environment. For communities that understand the immense value of ecology, the benefits of natural darkness, and the majesty of the night sky, high impact lighting for entertainment alone is untenable.

Sustainable Fireworks / Illuminated Drone Alternative

[SPARK](#) is a new sustainable way to inspire wonder. It's a safer, less disruptive alternative to polluting fireworks, balloons and confetti, and noisy illuminated drones. It involves thousands of biodegradable light sparks which silently, gently, and organically float through the air and then disperse and disappear.



Images [Studio Roosegaarde](#).

111 - Amsterdam draws up new rules to tone down its Christmas lights. December 2020. <https://www.theguardian.com/world/2020/dec/05/amsterdam-draws-up-new-rules-to-tone-down-its-christmas-lights>

112 - In Addressing Light Pollution, Ann Arbor Seeks To Tone Down Holiday Decorators. December 2021. <https://www.deadlinedetroit.com/articles/29317/in-addressing-light-pollution-ann-arbor-seeks-to-tone-down-holiday-decorators>

Guidelines for Decorative and Event Lighting

AVOID

Avoid using intensely bright, white and/or blue coloured lighting as shown below, and avoid lighting up trees and water.



Image source unknown.



Image source unknown.



Image source unknown.

Avoid overlighting, light clutter, and vividly coloured light sources as shown below.



Gingerbread House, Denver, US. Image Walter and Emily Hazard.



Image source unknown.



Image source unknown.



Image blachere.com.mx



Image source unknown.

IMPROVED

Choose warmly coloured, softly dispersed lighting with covered/hidden diodes/bulbs, as shown below.



Image Andy Holmes unsplash.com.



Image Laura Adai unsplash.com.



Image source unknown.



Image source unknown.



Image source unknown.



Image source unknown.

Below left, frosted covered, warm LED festoon lights. Light is soft, diffused, and easy on the eye.



Image thefairylightshop.com



Image source unknown.

Guidelines for Decorative and Event Lighting

Summary

- Less is best. A few lovely, thoughtfully chosen, well-placed lights makes more of a statement than overlighting.
- Use traditional colours - amber, red, and yellow that are reminiscent of candlelight. Avoid bright white, blue, purple and green lights.
- Avoid high-intensity, flashing lights.
- Choose LEDs which have hidden diodes/bulbs behind a frosted covering.
- Position light sources carefully and keep lighting levels low.
- Turn the light displays off at 11 pm or even better, set them to switch off automatically with a timer.
- All lighting events should be managed to minimise their impact. Even when temporary, lighting needs to be controlled.
- Ideally, light shows/displays/events are held indoors in appropriate venues to control light and provide a magical experience with no adverse impact on the nocturnal landscape and ecology outside. Dunedin does this successfully each year with their Summer Lights display, where the public can view the lanterns used in the Dunedin Midwinter Carnival inside a large warehouse.¹¹³

Responsible Lighting for Light Festivals, Creative Light Installations, Projection Mapping

Due to the adverse impact of ALAN, any lighting (temporary or permanent) for novelty and entertainment should undergo an environmental impact analysis before being installed, especially when located near water and in or close proximity to natural areas such as gardens, parks, reserves and forests. Otherwise there's the risk of inappropriate lighting as shown in the images below. ALAN is NOT benign so it needs to be applied with consideration, care, and caution, even for short-term events. Although large scale 3D projection mapping at light festivals and events have become popular around the world, where well known landmarks are illuminated - an effective solution is to instead, illuminate interior spaces rather than the exterior of landmarks and historic sites. This is important considering many of these installations are permanent displays, and when structures are near water and green zones. Another concerning trend is the use of projection mapping in natural landscapes such as forests. Due to the critical and beneficial role biodiversity plays in the sustainability of urban spaces, nocturnal placemaking needs to be valued and prioritised.¹¹⁴ Unfortunately, creative displays are even extending into naturally dark, pristine areas such as Iceland.

AVOID

Avoid white, vividly coloured, and intensely bright light sources (below left/centre/right). Avoid light clutter where there are countless light sources (below centre/right.) Avoid unshielded light sources (below left). It's particularly important to avoid such installations in natural settings.



Light trees, Palmerston North, NZ. Image Murray Wilson for stuff.co.nz



Light installation, Ayers Rock, Australia. Image source unknown.



Light installation, the Netherlands. Image studiooosegaard.net

Avoid bright white light (below left), projecting light directly into the sky (below centre), and bright, vividly coloured light near water (below right).



Copenhagen Light Festival. Image copenhagenlightfestival.org



Sharjah Light Festival 2011. Image Biju Thomas PhotoWorks.



2019 Copenhagen Light Festival. Image copenhagenlightfestival.org

Below left/centre, the Nordic Lights Event at the waterfront with displays that emit biologically disruptive and harmful white and blue light.



Nordic Lights Installation 2022 Toronto, Canada. Image Nordic Lights.



Nordic Lights Installation 2022 Toronto, Canada. Image Nordic Lights

113 - Dunedin Annual Inside Summer Lights Display. <https://www.eventfinda.co.nz/2015/mid-summer-lights/otago>

114 - An Overview of the Cognitive and Biological Effects of City Nighttime Illumination Including a London Case Study. Oct 2018. <https://theccd.org/article/41/an-overview-of-the-cognitive-and-biological-effects-of-city-nighttime-illumination-including-a-london-case-study/>

AVOID



Toronto Holiday Night of Lights Drive Thru. Image source unknown.



Blackpool Luminations Event, UK. Image source unknown.



Dynamic Digital Tunnel. Image ilmex.com

Light Festivals in New Zealand

Auckland has its Bright Lights festival, and Lantern Festival, and also held the Turama Light Festival in Albert Park in 2019. Wellington has LUX, Queenstown has the LUMA light festival, and Dunedin has its annual Midwinter Carnival Lantern Parade, which in 2021, used projection mapping on St Paul's Church in the Octagon for the first time. The general trend is for each event to get bigger, bolder and brighter. Auckland city holds the Bright Lights event on the Viaduct. LUMA light festival occurs annually during Queen's Birthday weekend at the Queenstown Gardens, which contains a large pond and is surrounded by Whakatipu lake. Due to these locations it's particularly important to consider the ecological impact of such events. However, with the various displays, there appears to be no concern about the biological/ecological impact and lighting is uncontrolled (light trespass and spill). Below left, inappropriate white lighting amongst the trees. Below centre, inappropriate white/blue lighting on water. Below right, inappropriate, vividly coloured light reflections on the lake, bright beams of light directed upwards, and skyglow above the event.



LUMA Light Festival, Queenstown 2017. Image Che McPherson.



Image Aiste Vasileviciute



LUMA Light Festival 2019. Image Escape Quest

Below left, inappropriate white/blue lighting. Below centre, vivid colours, light spill and reflections on the lake. Below right, uncontrolled lighting.



LUMA Light Festival, Queenstown Image Leigh Jeffery



LUMA Light Festival, Queenstown. Image Aiste Vasileviciute.



LUMA Light Festival, Queenstown Image Jordan McNally.

Below, inappropriate, high-intensity, vividly coloured, bright lights near/on the water.



LUMA Light Festival, Queenstown Image source unknown.



Auckland Bright Lights on the Waterfront. Image Rhonda Alborn.



Auckland Bright Lights on the Waterfront. Image Rhonda Alborn.

Below, inappropriate, high-intensity, vividly coloured LED lighting around trees.



LUMA Queenstown. Angus Muir Design. Image source unknown.

Light Festivals and Projection Mapping Overseas



Vivid Sydney. Sydney Harbour Opera House. Image Destination NSW.



Vivid Sydney. Image Destination NSW.



Vivid Sydney, Sydney Harbour. Image Destination NSW.

Below, projection mapping onto natural objects in natural landscapes.



Projection mapping Saga, Japan. Image projection-mapping.org



Projection mapping, Koh Phangan, Thailand. Image Philip Frank.



Projection mapping, Koh Phangan, Thailand. Image Philip Frank.



Projection mapping on a waterfall.. Image projection-mapping.org



Projection mapping on a forest right beside water. Image source unknown.

Below left, this permanent light display was installed even though the building is right beside the water. It beams 1 million lumens onto the south façade of the building from March to December, five nights a week (Wednesday – Sunday). No environmental impact study was undertaken.



theMART, Chicago. Image www.installation-international.com



Permanent light display at the Tower of David, Israel.

Below left, “Lights for the Wild” at Taronga Zoo, Sydney during Vivid Sydney. Ironically, this light show featured some of Australia’s most endangered aquatic species even though light pollution is a serious threat to them. Below centre, “Oasis” is an installation “reminiscent of fireflies, fields of flowers and the sea” - yet these organisms are all harmed by ALAN. Many light installations mimic nature whether it’s the Aurora, fireflies, glow worms, phosphorescence, flowers, birds, glowing fungi, water, etc - however, these displays disconnect us from an authentic connection with nature, the crucial role of darkness for health and wellbeing, and respecting ingrained biological cycles that life on Earth evolved with.



Lights for the Wild, Taronga Zoo, Sydney. Image Vivid Sydney.



Oasis Light Installation. Image Vivid Sydney.



Aurora Light Show, Guild Hall, London. Image Festival.org



Lights for the Wild, Taronga Zoo, Sydney. Image AAPImage.



Lights for the Wild, Taronga Zoo, Sydney. Image Christineknight.me



Waterlicht Installation, Museumplein, Amsterdam. Image Roel Driever.

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For outdoor displays, keep lighting levels low, subtle and soft, favour warm colours (red, orange, yellow), and ensure all displays turn off after peak viewing hours. Avoid installing light displays in parks, gardens, forests, and near bodies of water. Ideally, keep light installation inside, as shown below left/centre. The Light Up Lancaster Light Festival 2019, celebrated the 50th anniversary of the Apollo 11 mission, with one display called 'Museum of the Moon' by Luke Jerram, a seven metre moon which was suspended at Lancaster Priory Church. It's also been displayed in other interior spaces (below right.) Beautiful, well executed designs like this can be displayed during the day so they don't have to be limited to the night.



2019 Light Up Lancaster Light Festival. my-moon.org



Museum of the Moon by Luke Jerram. my-moon.org



Image copenhagenlightfestival.org

Alternatively consider creative installations that minimise light spill into the environment, such as the inflatable light installation featured below left/centre, which people experience by walking inside.



Above left and centre - the exterior of the inflatable light installation "Dodecalis Luminarium".



Above right, inside the installation. Images Dubai-Expo 2020.

Below left, this installation uses warm colours and soft light sources with hidden diodes. Below centre, although the lighting in the window is white, it's output is OK, and the red lighting is controlled (vertical lighting that is capped by the eaves), and it's a safer, less disruptive spectrum.



Angus Muir Design. LUMA, Queenstown. Image Jordan McInally



LUMA, Queenstown. Image Scott Kennedy.



Squiggle Installation, Jerusalem. Angus Muir Design.

Below right, the only reason the installation below right is included here is because it's not displayed outside. Although it emits high levels of health disrupting white light, people can choose if they want to view it and it's not impacting the external nighttime environment.



Image Instagram



Wellington LUX Festival. Image source unknown.

IMPROVED

Instead of adding more light to the nightscape, hold creative, magical light displays inside of large buildings and covered venues, so the light is controlled. This significantly reduces the amount of bright, vividly coloured light being added to the environment. Depending on the venue, the display can also be enjoyed during the daytime. Below, some creative projection mapping held indoors.



Image helloendless.com

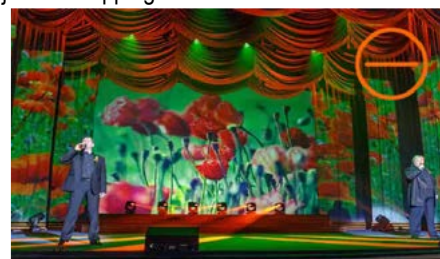


Image installation-international.com

Responsible Lighting for Interiors and Accommodation Providers

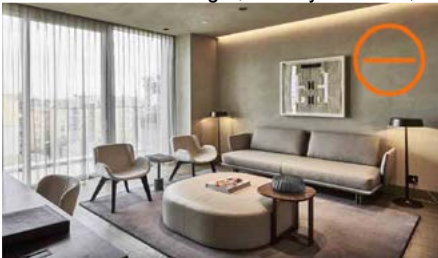
Responsible lighting offers many benefits without a single drawback. Not only can responsible lighting/best lighting practices be a distinguishing feature of a business, it can also take the health, well-being, and comfort of guests to another level of care, providing that extra something special. For businesses that provide Dark Sky experiences, services, and facilities, please also refer to Responsible Lighting for Dark Sky Ventures pg 61.

Research confirms darkness at night aids restful sleep for health and well-being so all artificial light at night should be carefully managed to minimising unnecessary disruption to circadian rhythms. This can be achieved via using the right light sources, positioning them with care, lowering lighting levels, and controlling their use. The following guidelines can vastly improve interior lighting conditions whilst providing visibility and safety, and increasing guest comfort.

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Key Factors to Consider with Interior Lighting

Consider using recessed lighting (where the light source itself is not visible) to softly wash light on vertical surfaces as shown, below left. Note the recessed lighting at the edge of the ceiling. This creates an inviting and welcoming effect and it's also pleasant and easier on the eyes than direct light sources which can cause glare and discomfort. The floor lamps on each side of the couch direct light downwards and the bulbs are hidden. This provides pleasant illumination for reading and encourages a state of relaxation. During the day, the interior lighting is complimented by natural light via the floor to ceiling windows. Below centre, shows desk lamps that emit softly diffused and evenly dispersed light which provide warmth and comfort. Below right, warmly coloured, softly diffused lighting that creates a comfortable and cosy atmosphere.



Hotel VUI, Milan, Italy. hotelviumilan.com Image Tiziano Sartorio.



Image hotelviumilan.com



Upper House, Hong Kong. Living Room. Image Ben Lee [flickr.com](https://www.flickr.com/photos/benlee/)

Below left/centre, consider recessed and dimmable, warm coloured, strip lighting. Below right, indirect wall mounted light source (frosted glass or acrylic can help reduce the glare produced by LED bulbs/diodes). Also, favour keeping lighting levels are low as practical.



Image avenila.com



Image avenila.com



Image source unknown.



Novatel Sea Tower, Binh Dinh, Vietnam. Image SLADesigners.com



Flowing Cloud Township Villa, Tonglu, China. archdaily.com Image Zhi Xia.

Hallway and Lobby Lighting

Below left, well executed hall way lighting that is warm, indirect, softly dispersed and low to the ground. Below centre, recessed, warm, indirect lighting. Below right, indirect, recessed, warm lighting.



Buda Hotel, Chengdu, China. Image Chuan He, Here Space-Photography.

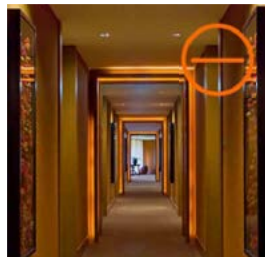
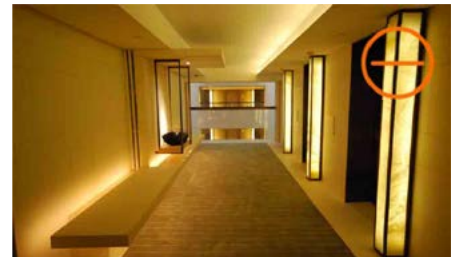


Image source unknown.



Upper House, Hong Kong. Image Ben Lee [flickr.com](https://www.flickr.com/photos/benlee/)

Avoid night lights that are white, blue or green in colour. Favour orange or red lights and position them at floor level, as shown below. The spectral power distribution (SPD) graphs below, show zero blue light is emitted from both types of blueblocking bulbs (amber and red).



Images blockbluelight.co.nz

Bedroom Lighting

The lighting in bedrooms is particularly important to provide guests with the optimal conditions to support quality sleep. It's best to avoid using ceiling downlights at night because when light comes from above, the body thinks the light is from the Sun and that it's day time. (This happens because photosensitive cells in the retina are clustered lower in the retina.) If ceiling lighting is used, it's best to ensure it's recessed and lighting levels are low. The two images below, show **exemplary** illumination that supports comfort, relaxation, health, well-being, and sleep. There are no exposed bulbs/diodes, the lighting is warm, adaptable and lighting levels can be lowered.



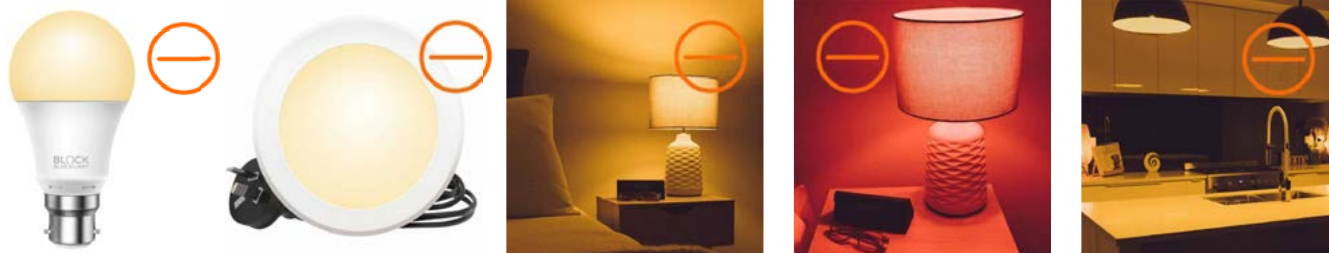
Novatel Sea Tower, Bedroom, Binh Dinh, Vietnam. Images SLA Designers.

Below, recessed lighting above the bed is softly dispersed, with flexible, well-directed lighting aimed at the headboard, and for bedtime reading if needed. The side tables are gently illuminated providing good visibility for accessing the drawers and other items. Ideally, this kind of lighting scenario can be dimmed and colour tuned - changing from warm white (2700) K to an amber colour (1800-2200 K).



Hotel VIU, Milan. Image Claus Brechenmacher & Reiner Baumann Photography.

To aid sleep, provide rooms that feature light sources with low to zero blue wavelengths of light. The blue blocking LED bulb (below left) fits into an E-27 or screw-in bayonet B-22 light socket, for bedside/table/floor lamps, as well as for ceiling downlighting. The LED downlight (second from the left) also has zero blue wavelengths of light. Look for blue blocking LEDs that are also flicker-free with low electrical magnetic radiation (EMF).



Images blockbluelight.co.nz

It's important to provide properly fitted blackout curtains to make rooms completely dark at night. This prevents light intrusion into the room (as well as preventing light from inside the room spilling outside into the nightscape). Also ensure there are no gaps around doors, which can allow light to intrude or escape.

Bathroom Lighting

Keep in mind bright, white lighting for bathrooms should be avoided because this can disrupt circadian health and disrupt sleep. As guests usually use the bathroom before going to bed at night, it's beneficial for bathrooms to have indirect, warm (1800-2200 K), softly diffused, evenly dispersed lighting. Such lighting is also flattering and appealing which can lead to positive reviews and more bookings.



Upper House, Hong Kong. Image Ben Lee [flickr.com](https://www.flickr.com/photos/benlee/)



Image source unknown.



Crampton & Smith Builders.



Image source unknown.



Image Crampton & Smith Builders.

Gym Lighting

AVOID

Gyms are often overlooked so lighting can be commonly harsh, clinical, overlit and an unsafe colour and spectrum. For guest health, comfort and safety, lighting should be well designed and thoughtfully executed. Avoid harsh downlighting, light clutter, and having the lighting intensity too high. Also avoid vividly coloured lighting as shown below left. Below centre, while the lighting is recessed which avoids glare, the white light is an inappropriate colour and spectrum. Lights that can be colour tuned to a warmer colour as well as dimmed are a good option, especially after it gets dark. Although supporters of "circadian/human-centric lighting" encourage the use of bright white LED lighting in the morning and during the day, it's important to understand that (unlike natural sunlight) the vast majority of white LEDs are lacking adequate protective red wavelengths and missing infra red light that can counteract the damaging, oxidative effects of blue wavelengths of light.

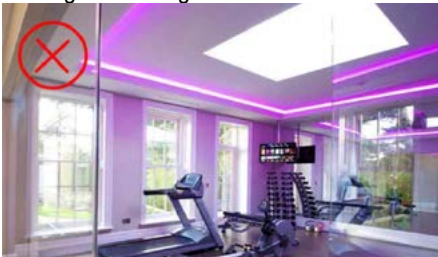


Image Sona Technology.

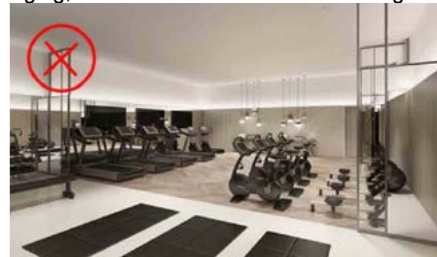


Image source unknown.



Image pinterest

IMPROVED

Choose warm light sources (1600-2200 K) with minimal blue and green wavelengths of light. Below left, subtle, soft, warm, recessed lighting as well as soft downlighting from the ceiling. Ideally, both can also be dimmed and colour tuned to further reduce lighting levels and add extra ambience late at night. Below centre, in gyms with no windows, warm, recessed lighting in the ceiling can provide diffused light that is comfortable, welcoming and complimentary to the space. Dimming the lighting at night is also helpful.

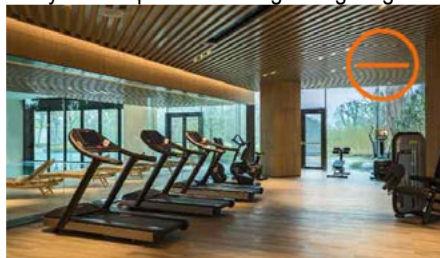


Image Renaissance Suzhou Taihu Lake Hotel Suzhou, China.

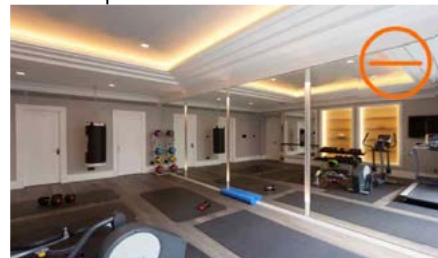


Image [strada.uk.com](https://www.strada.uk.com/)

Also, be aware of the disruptive, bright, white light emitted from the LEDs inside fridges and automated ice/drink/snack dispensers. If possible, choose options with soft, warm coloured lighting. (If this is impractical, tape a strip of orange coloured clear plastic gel over the light source.) It's also helpful to avoid appliances with bright LEDs such as TV screens, stereos, modems, electric jugs, fans, heaters, alarm clocks, etc.

AVOID



Image www.carousell.sg

If this isn't possible, use little stickers called "Light Dims" (<https://www.lightdims.com/index.php>) which can be applied over small LEDs. <https://www.rapalloav.co.nz/product-category/default-category/accessories/other/lightdims-led-blocker/?v=d76c77a873e2>

Even the illumination of room numbers can be improved, as shown below. Both examples show subtle and soft forms of indirect lighting, which are easier on the eye. Ideally, these examples would be warmer in colour.



Image bosisiosign.com

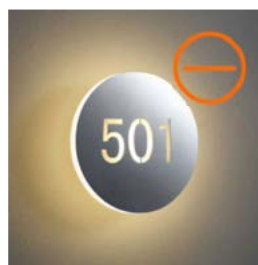


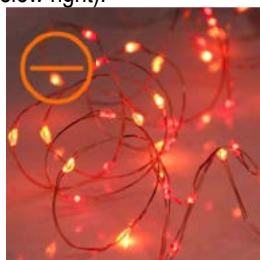
Image ultrabeamlighting.co.uk

Fairy Lights for Interior Lighting

Choose warm coloured options as shown below. Ideally, the best decorative lights should be orange to red without exposed diodes so the light is soft and pleasant on the eyes (below right).



Image source unknown.



Sunset Fairy Lights. Image www.qbis.uk



Red Fairy Lights. Image www.qbis.uk



Cluster Berry Lights. Image www.qbis.uk

Although these factors on their own, may appear to be minor, they each add up to greatly enhance a guest's experience. The previously suggested guidelines are also in keeping with best lighting practices that protect and preserve the nocturnal landscape and the night sky. As awareness continues to increase about the widespread use of harsh, bright, white LED light sources and the harm of ALAN, coupled with renewed appreciation for the value of darkness and the many benefits of sleep, there is a wonderful opportunity for accommodation providers to highlight the extra steps they take to support the health, well-being, and comfort of their guests via responsible lighting. Furthermore, responsible lighting can be a distinguishing feature and asset for any business that wants to promote and embrace health and well-being. It's also strongly complementary and supportive for any business in a community that is aspiring to attain Dark Sky Reserve status with the International Dark Sky Association (IDA).

In summary

- Ensure best lighting practices are also applied to exterior lighting.
- Choose light sources that emit a warm colour (1800 K to 2200 K is ideal). Go no higher than 2700 K.
- Make lighting as controlled and adaptable as possible via dimming, sensors/motion detectors, timers, and colour tuneable LEDs.
- When possible, chose indirect, recessed, and/or shielded lighting. (Avoid direct lighting with exposed bulbs/diodes.)
- For spot lighting for seating, provide lampshades that cover the light source and direct light downwards.
- Favour recessed lighting at the floor level for hallways and stairs.
- Keep the lighting in bathrooms warm coloured, indirect, softly diffused, and evenly distributed.
- For night lights, favour orange or red options that are positioned close to the floor.
- Support your guests' quality of sleep by ensuring the bedroom completely dark at night. (Curtains should be well fitted blackouts to prevent unwanted light intruding into the room, and to also avoid light from inside the room escaping outside into the nightscape.)
- Ensure doors are close fitting so there is no gap at the bottom and sides, which allows light to intrude into the room.
- Cover any small but bright LEDs on electrical appliances with Light Dims.

Responsible Lighting for Dark Sky Ventures, Eco Tours and Accommodation

This guidance pertains specifically for businesses that provide dark-sky activities, services, and experiences. (It can also apply to eco-tourism where the protection of flora, fauna, and the nocturnal landscape are crucial.) Responsible lighting can be achieved by selecting the right light sources, positioning them with care, and controlling their output and use via dimming, timers and sensors. Lighting for buildings, pathways, parking and stargazing amenities should be carefully executed in order to provide safety, visibility, and effective wayfinding at night without ruining night vision and harming the very asset your business depends upon – natural darkness at night. First and foremost, question how much lighting is needed because it is all too common to over light. Once lighting requirements are clearly established, apply the guidelines outlined in this document.

One of the most important aspects when providing dark sky experiences is to avoid bright, white lighting as this prevents dark adaption (the ability to see in low light situations) which is required to view and appreciate the night sky. While warm orange to red lighting is best, it's still important to minimise the intensity of lighting by keeping lighting levels low, and to also position light sources in a way that the bulbs/diodes are hidden/recessed from view, and to also position lighting low. Favour shielded, indirect, softly dispersed, evenly distributed, warm orange to red lighting. When possible, avoid lighting horizontally. Instead, illuminate vertical surfaces to assist orientation and wayfinding. Choose recessed lighting (where the light source itself is not visible) to softly wash light over vertical surfaces. This is more pleasant and easy on the eyes than direct light sources which can cause glare and discomfort, hindering vision and effective wayfinding. It's also helpful to provide guests with information about how to use interior and exterior lighting responsibly, as this will help them optimise their experience of appreciating the nocturnal landscape and the night sky.

IMPROVED



Lindis Lodge, Ahuriri Valley, NZ. Images www.theindisgroup.com



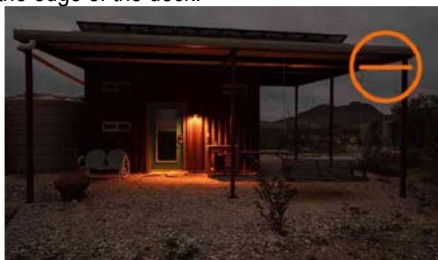
Lindis Lodge, Ahuriri Valley, NZ. Images www.theindisgroup.com

With buildings made from glass or with large windows, it's crucial to be careful with the choice of light sources, how they are positioned, and used. It's also important to minimise lighting levels and to reduce the reflection and escape of light as much as possible. The two photos below, of a glass PurePod with warm coloured, dimmed lighting supports guest comfort, night vision, and health. It's also more respectful to the nightscape and environment. Flexible, adaptable lighting is key.



PurePod Banks Peninsula. Images www.purepods.com

Below left, shows thoughtfully placed, minimal lighting to illuminate only the area that is needed (the entrance/exit). The light source itself is hidden to support vision and navigation. There is also zero upward light spill and the colour of light is warm (1800-2200 K). Below right, note the subtle shielded light source at the edge of the deck.



Javelina Hideout in Terlingua Texas, US. Images Stephen Hummel.

Below left, all lighting is warm, shielded and directed downwards. Below centre/right, note the warm orange lighting and the way the deck covering prevents upwards light spill into the sky. Below right, the interior lighting can also be dimmed and/or switched off to allow stargazing.



Big Bend Stargazer, Terlingua Texas. Image source unknown.



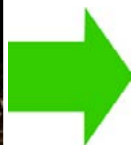
Chisos House Accommodation, Fossil Knob Ridge, Big Bend, Texas. Images Spencer Millsap.



Below left, poorly positioned lighting resulting in glare and light pollution. Below right, the same venue with improved lighting.



Porch El Tovar, Grand Canyon National Park.



The same porch with responsible lighting. Images R. Lane.

Below, well-controlled, red lighting to support night vision and stargazing.



Astro Cafe, Mt John, Takapō (Tekapo). Image tripadvisor.com



Battledeads Dark Sky Observatory, Northumberland. Image Handout.



Stargazing Forestry England. Image Lyle-McCalmont.

Thoughtfully illuminated hotsprings. Below left, improvements could be made with shielding and better positioning of light sources to reduce glare.



Takapo (Tekapo) Hot Springs. Image tekapostargazing.co.nz



Springs Chena, Alaska. Image www.terrageria.com

Summary

- Ensure best lighting practices are applied to all lighting, interior and exterior, including parking areas and signage.
- Choose light sources that emit a warm colour/spectrum (1600 K – 2200 K.)
- Ensure lighting is controlled and adaptable via dimming, sensors/motion detectors, timers, and tuneable LEDs.
- Chose indirect, recessed, and/or shielded lighting. (Avoid direct lighting with exposed bulbs/diodes.)
- Ensure room lighting is flexible so guests can increase/ decrease/adapt the lighting to suit their needs.
- Use glow-in-the-dark paint or reflective tape to edge steps, paths and doorframes as an energy-neutral alternative to lighting.
- For pathways, use glow-in-the-dark gravel and glow-in-the-dark disks.

Exemplary Exterior Lighting, Nocturnal Placemaking and Respecting Darkness

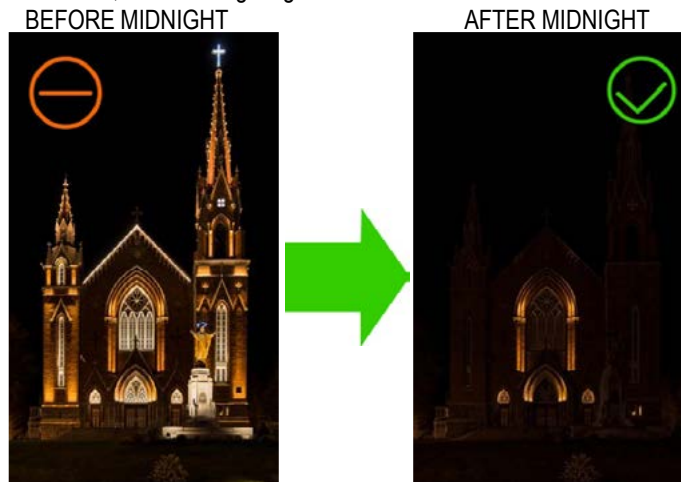


Flowing Cloud Township Villa, Tonglu, China. archdaily.com Image Xia Chu. .



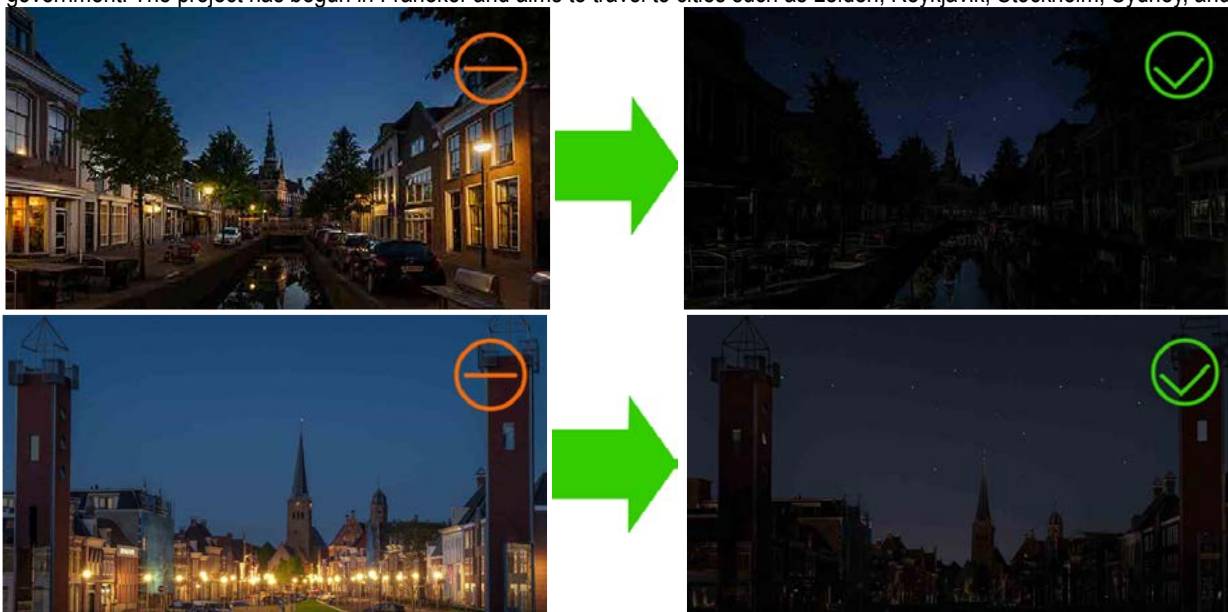
Yunxi Town in Yan Zhangjiakou, Hebei Province, China. Images litawards.com

The two images below show subtle, well-directed, controlled lighting that uses minimal white. Curfews are also applied to reduce lighting impacts.



Sainte-Agnès Church in Lac-Mégantic, within the [Mont-Mégantic International Dark Sky Reserve](http://montmegantic.org), Quebec, Canada by Rémi Boucher

In 2021, the Dutch city of Franeker initiated the project “SEEING STARS”, a collaboration between the residents, government, and businesses of Franeker, Unesco Netherlands and Studio Roosegaarde, to switch off all non-essential household lights, billboards, and street lights to raise awareness about the value and importance of having access to the night sky. By removing light pollution on a city-wide scale, “SEEING STARS” enables everyone to reconnect with the universe and experience the magic of starlight again. Public safety is ensured in close collaboration with the local government. The project has begun in Franeker and aims to travel to cities such as Leiden, Reykjavik, Stockholm, Sydney, and Venice..



Images Photography Albert Dros and Merel Tuk.

Energy Neutral Illumination Alternatives

Instead of using artificial light sources, consider glow-in-the-dark eco-chips, photoluminescent line marking for roads and pavements, or eco-discs, as shown below, and/or reflective tape/markers. Eco-discs can be used along pathways to assist wayfinding at night and glow-in-the-dark/reflective tape can be used on the edges of steps and applied to door frames to highlight entrances. The eco-chips, eco-discs, road line marking, and tape are available in New Zealand. Although the light emitted from these materials is very low compared to electrical artificial light sources, in ecologically sensitive areas it may be prudent until research becomes available, to favour green options as this “colour” occurs in nature as bioluminescence. (Research is currently being undertaken at Exeter University in the UK by Dr. Emma Stone, to investigate the impact of these materials on bats. The results are planned to be published in September 2022.)



Glow-in-the-dark star path, China. Image [Nevana Designs](#).



Above centre/right, Van Gogh cycle path inspired by the painting *Starry Night*, Eindhoven, Netherlands. Images [Studio Roosegaarde](#).



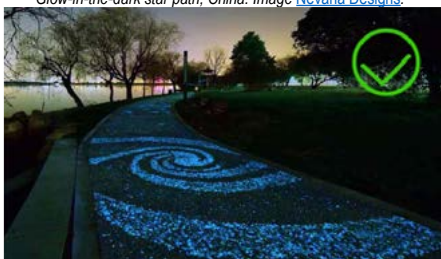
Glow-in-the-dark star path, China. Image [Nevana Designs](#).



Glow-in-the-dark Starpath Crete. Image [Nevana Designs](#).



Glow-in-the-dark star path, China. Image [Nevana Designs](#).



Glow-in-the-dark star path, China. Images [Nevana Designs](#)



Glow-in-the-dark eco-chips Korea. Image [Nevana Designs](#).



Glow-in-the-dark star path. Image [Taico Brands](#).



Glow-in-the-dark eco-discs. Image [Taico Brands](#).



Glow-in-the-dark road markings. [Taico Brands](#).

Recommended Reading

Dark Nights, Bright Lights: Night, Darkness, and Illumination in Literature. Susanne Bach and Folkert Degenring. Anglia Book Series, Vol. 50. Berlin: De Gruyter. Bach, S., Degenring, F. (Eds.). (2015). doi:10.1515/9783110415292.

[The Value of Darkness: A Moral Framework for Urban Nighttime Lighting. Taylor Stone.](#)

[Re-envisioning the Nocturnal Sublime: On the Ethics and Aesthetics of Nighttime Lighting. Taylor Stone.](#)

[The End of Night. Paul Bogard.](#)

The value of the night sky. In Meier, J., et al. (eds.), *Urban Lighting, Light Pollution and Society*, pp. 267–283. New York: Routledge.

[Looking Up to the Stars. A Call for Action to Save New Zealand’s Dark Skies for Future Generations to Come.](#)

[Is Street Lighting Damaging Our Health? Cree White Paper April 2022.](#)

[Incandescent: We Need to Talk About Light. Anna Levin.](#)

[At Day’s Close: Night in Times Past. Roger Ekirche.](#)