



Guidelines for the Reduction of Light Pollution in the Maltese Islands

PUBLIC CONSULTATION DOCUMENT

Table of Contents

1. INTRODUCTION.....	2
1.1. Preamble.....	2
1.2. Scope and Principal Objectives of the Guidelines.....	2
2. ELEMENTS OF ILLUMINATION PRACTICE.....	4
3. THE EFFECTS OF LIGHT POLLUTION	4
3.1. Glare	4
3.2. Light Intrusion or Light Spill	7
3.3. Sky Glow	8
3.4. Light Emissions Measured from Satellite Data	10
4. NEGATIVE IMPACTS OF LIGHT POLLUTION	13
4.1. Human Health.....	13
4.2. Crime and Safety	14
4.3. Enjoyment of the Natural Night Sky	15
4.4. Ecosystems and Biodiversity	15
4.5. Waste of Energy	17
5. LEGAL AND POLICY FRAMEWORK.....	19
5.1. Strategic Plan for Environment and Development (SPED).....	19
5.2. The Environment Protection Act, 2015 Part VI, Article 58	19
5.3. The National Environment Policy (NEP) and the National Strategy for the Environment (NSFE).....	19
5.4. The National Biodiversity Strategy and Action Plan 2012-2020 (NBSAP).....	20
5.5. The Flora, Fauna and Natural Habitats Protection Regulations (SL 549.44)	20
5.6. Environmental Assessment	21
5.7. The Marine Policy Framework Regulations (SL 549.62)	21
5.8. Development Control Design Policy, Guidance and Standards 2015 (DC 2015).....	22
5.9. The Development Notification Order (Legal Notice 211/16)	22
5.10. Site Specific Policies	23
5.11. Other Applicable Legislation.....	24
6. GUIDELINES.....	25
6.1. General Principles	25
6.2. Using well-designed lighting only when required.....	25
6.3. No direct emission to the sky	26
6.4. Colour Temperature.....	27
6.5. Lighting for Security	27
6.6. Searchlights and lasers	27
6.7. Design and Planning of lighting installations.....	27
6.8. Outdoor Lighting in the ODZ areas and in Large Development	29
6.9. External Lighting in Urban Areas	30
6.10. Street Lighting.....	31
6.11. Outdoor Recreation Areas and Sports Lighting.....	33
6.12. Architectural Lighting of Buildings and Monuments.....	34
6.13. Warning Lights.....	35
6.14. Billboards and Signs.....	35
7. DESIGNATION OF DARK SKY HERITAGE AREAS	36
8. EXEMPTIONS	38
9. DEVELOPMENT APPLICATIONS REQUIREMENTS	38
10. GLOSSARY OF TERMS.....	38

1. INTRODUCTION

1.1. Preamble

In the last century the use of artificial light has increased exponentially, contributing significantly to quality of life and the economy, primarily by making possible night-time commercial and industrial activities while facilitating night-time leisure and transportation.

Artificial light therefore offers valuable benefits to society. It extends hours of activity and facilitates education, leisure, recreation, travel and economic activities beyond the diurnal hours. It is also an essential aid to human safety and security as humans tend to feel more secure in an adequately lit environment. This is equally applicable indoors as well as outdoors.

Despite its benefits, if used inappropriately, artificial or man-made light can be of a nuisance and is harmful to human health and wildlife. Inappropriate lighting, which is independent from the efficacy of the luminaires installed, is also a waste of energy and contributes to climate change by increased carbon emissions in the atmosphere. Inappropriate lighting wastes energy by illuminating areas which do not benefit from being lit (such as illumination directed upwards) and money is literally wasted in this manner. The end-user therefore benefits from suitable lighting which efficiently illuminates only the areas where lighting is required.

1.2. Scope and Principal Objectives of the Guidelines

As has happened in all developed countries, the Maltese Islands have, these last five decades, experienced a large increase in the amount of installed external illumination, concurrently with the Islands' economic growth.

During these years external artificial light has been used erratically with little concern on the negative impacts of spill-over light, or in other words, light which shines or trespasses into areas beyond that area, place or subject intended to be illuminated. This is termed 'obtrusive light' or 'light pollution'.

The issue of light pollution was highlighted about three decades ago. Gradually, a number of NGOs mounted pressure on governments, throughout the world, to introduce legislation to either install appropriate lighting or to curb lighting in the most sensitive areas. Properly designed lighting is not only beneficial to the community in terms of considerable savings in energy consumption and reduction in the carbon footprint but also to the benefit of human health and safety and enjoyment of the natural nightscape. Moreover, it minimises disturbances to wildlife and ecosystems. There are also benefits related to scientific observations that require minimal light pollution conditions.

Controlling light pollution does not translate into unnecessary development restrictions or banning of all artificial lighting. Artificial lighting is required especially in an urban environment. Proper lighting schemes constitute a more intelligent use of

lighting by installing less-intrusive luminaires with no wasted light spilled in the sky or onto areas which are not meant to be illuminated. In this way, lighting serves its function in a more efficient, environmentally friendly and sustainable manner, without unnecessarily annoying or disturbing neighbouring activities.

Well-designed lighting renders the nightscape more attractive and enhances the quality of the night time experience. It can lead to addressing coupling between the safety and security without unnecessarily degrading the natural night time experience. The magical experience of the night sky in rural areas is lost through ill-designed lighting installations. Thus, the scope of this document is:

To halt the increase in the extent of light pollution in the Maltese Islands and to strive to reduce the negative effects that artificial light currently has on amenity, safety, the environment, landscape and the night sky.

Inappropriate installations and overuse of outdoor lighting adversely affects the environment and can degrade human health, safety and recreation. Artificial light levels in the environment have locally increased significantly in the past years and it is only appropriate that this trend is not only halted but also reversed.

In recent years, the Malta Environment and Planning Authority (MEPA) introduced policies which aim at safeguarding against light pollution, such as policy GZ-UTIL 5 of the Gozo and Comino Local Plan and the good practice guidance (G27) of the Development Control Design Policy Guidance and Standards 2015. These are however aimed at future development. The challenge is not just to control light pollution from the development currently being proposed or from that yet to be proposed in the future, but to reduce the light pollution currently being experienced on the Islands. For this reason, the guidelines identify four main objectives.

1. To increase the awareness of the general public on the negative impacts of obtrusive light and the benefits of well-designed external lighting.
2. To produce a guide to assist individuals and organisations to make the best use of external, artificial light for a more sustainable environment, which is safer and more attractive, both visually and economically.
3. To emphasise the need to protect the existing 'dark' rural areas from unnecessary artificial light.
4. To help assessors of development applications in their evaluation of applications which comprise or likely to include external lighting and/or spill of unwanted light from internal areas.

2. ELEMENTS OF ILLUMINATION PRACTICE

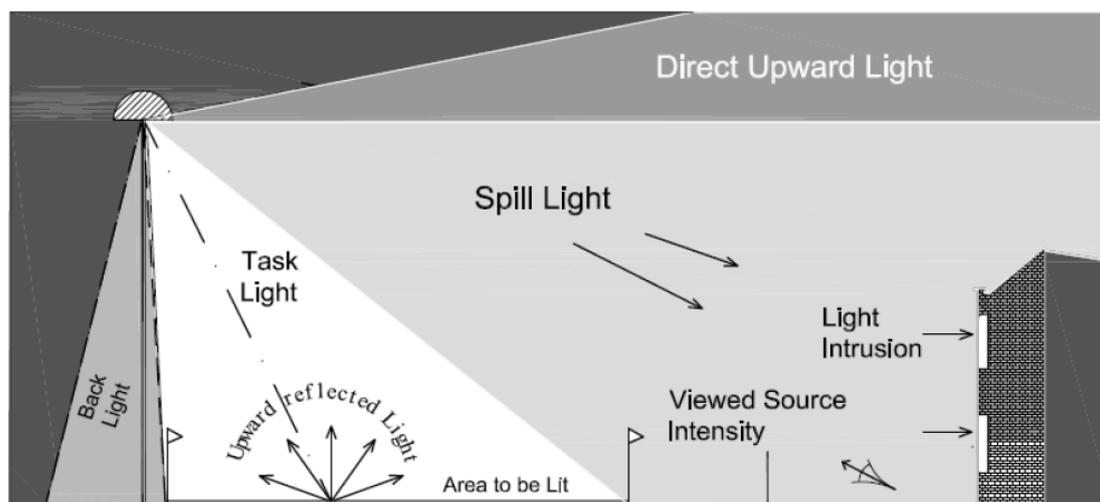


Figure 1 - Different contributors to light pollution¹

Figure 1 depicts the different component and characteristics of artificial lighting, which gives rise to light pollution to various degrees. While the reflection of the area to be lit is unavoidable, it can be minimised by avoiding over illumination and by using the appropriate levels of light. A more serious form of light pollution is the direct emission from luminaires in areas and directions which are not meant to be lit, particularly direct upward light into the sky.

3. THE EFFECTS OF LIGHT POLLUTION

The following chapters classify the various forms of light pollution, their visual effect and how humans and the environment are affected.

3.1. Glare

Glare is caused by intense and excessive amount of light shining directly into the eye, mostly from the source of unshielded luminaires. Glare causes visual discomfort and can also significantly impair vision by reducing contrast sensitivity and the ability to see contrasts as well as the perception to distinguish colours. Glare also inhibits the development of dark adaptation or dark vision during which the eye rods are enabled for vision during low light intensity.

Glare is a safety hazard and inappropriate lighting fixtures are actually counterproductive to the very reason why they had been installed in the first place. This is why glare is considered to be the most serious form of obtrusive light.

¹ Guidance notes for the reduction of obtrusive light, Institute of Lighting Professionals, 2011

It has to be understood that the effects of glare on the human vision depend very much on the individual and type of light. For example, elderly people lacking the ability of adapting to fast changes in light levels are affected more from disability glare. It is also known that glare from bright white light and from luminaires with a high colour temperature (emitting more blue light) causes more strain and fatigue on the eye. Experience also showed that bright white light is not only more glaring when it is emitted by the luminaire itself, but also from the reflection on the ground and buildings. Motorists are less able to adapt to fast changes in contrast and perceive the areas between lamps as dark, particularly if such areas are lit by fixtures which cause glare.

Glare also adversely affects nocturnal animals, primarily by causing disorientation, which may lead to their death. Additionally, glare competes with the reproductive cycle particularly of bioluminescent animals.



Figure 2 (photo M. Nolle): Example of glare from inappropriate architectural lighting



Figure 3 (photo M. Nolle): Glare from non-cut-off decorative lamps

Deliberate, periodic changes in the intensity of light is normally used to seek attraction, as in the case of advertising. A more recent trend is the use of LED billboards for advertising, which beside the rapid change in content are often very bright. This type of illumination gives rise to glare and visual discomfort. It also distracts motorists and may therefore constitute a significant safety hazard.



Figure 4 (photo M. Nolle): LED billboards are a safety hazard to motorists and pedestrians due to the high intensity of light (when compared to other light sources), continuous rapid change in content and glare that they produce

3.2. Light Intrusion or Light Spill

Light intrusion or light spill refers to light trespassing into an area beyond the intended illuminated area or subject. It is mostly caused by inappropriate light fixture selection and installation, ineffective shielding and/or excessive light output.

Intrusion of light is a nuisance and of particular concern when the light shines through windows into living spaces and private properties. A lighting nuisance survey carried out in the UK in 2010² revealed that:

- 83% of the respondents had their home view of the night sky affected by light pollution,
- 68% have fitted thicker curtains,
- 50% of the respondents had their sleep hindered by light shining in their bedrooms,
- 37% said that excess light shines across their drive or garden,
- 30% said that light intruded into another room in their property,
- 14% moved to a different room to sleep.

When asked about the main source of light pollution, the survey revealed that:

- 89% of the respondents said that road lighting is the number one source,
- 79% said security lighting on private residences,
- 56% lighting from businesses, and
- 53% lighting from public service facilities (such as sports grounds).



Figure 5 (photo M. Nolle): Activities within a naturally dark area cause glare and light spill onto the rock face and into the ecologically sensitive surrounding countryside

² <http://www.cpre.org.uk/resources/countryside/dark-skies/itme/1973-cpre-and-cfds-lighting-nuisance-survey-2009-10-results>

3.3. Sky Glow

Sky glow is caused by light going upwards (directly upwards; at shallow angles above the horizontal or by reflection from objects and the ground) which is then diffused and scattered by aerosols (molecules, droplets and dust) in the atmosphere. The result is a general brightening of the night sky and night time celestial features “drown” in the bright background.

The scattering process depends very much on the wavelength (colour) of light. Light of shorter wavelengths (blue) scatters more than light of longer wavelength (red). This is also the reason why the clear day-sky is blue. Research has shown that bright white light creates about four times more sky glow than orange light.³

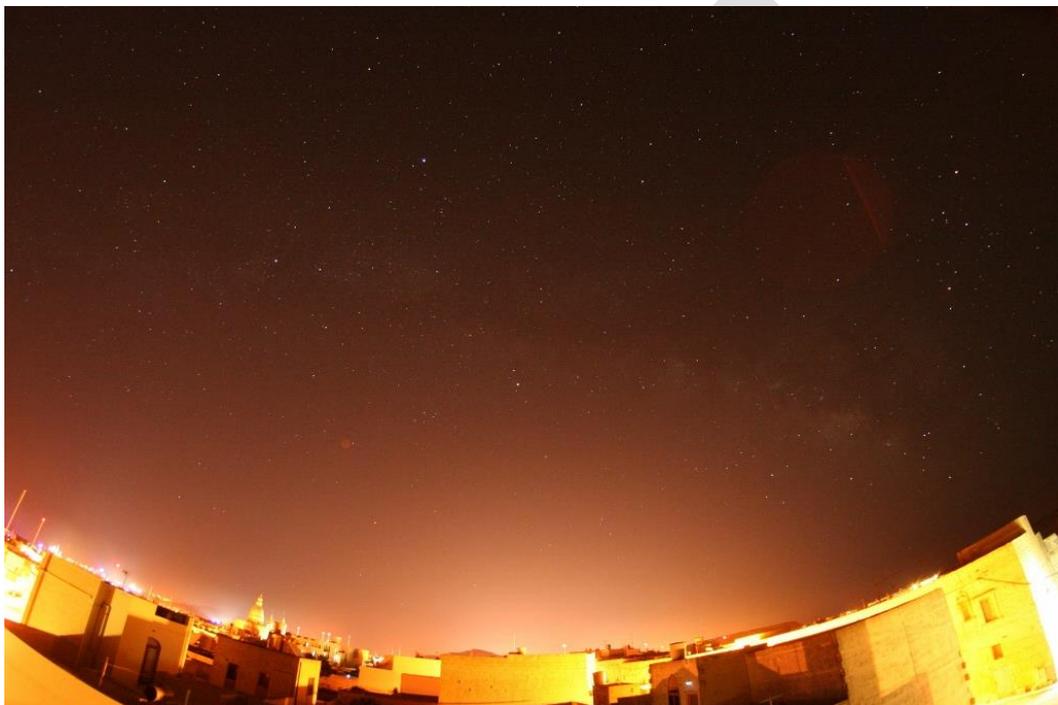


Figure 7 (photo M. Nolle): The general sky glow by multiple light sources strongly reduces the contrast of the night sky and the visibility of stars and other objects, such as the Milky Way. Densely populated areas often create a dome of light as seen from suburban and rural areas

³ Duriscoe et al., 2007, Measuring Night-Sky Brightness with a Wide-Field CCD camera, publications of the Astronomical Society of the Pacific 119, p. 192-213.



Figure 8 (photo M. Nolle) Sky glow from distinct sources (churches on the left and sports ground on the right)

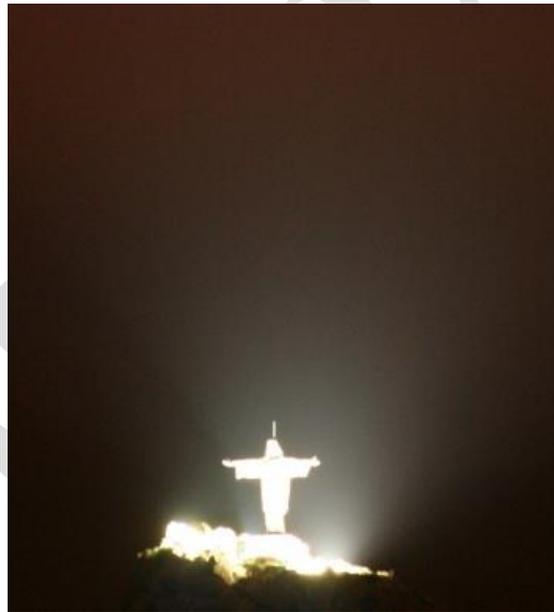


Figure 9 (photos M. Nolle): Another example of sky glow in a rural area from non-shielded inappropriate light sources

3.4. Light Emissions Measured from Satellite Data

Light which is emitted directly upwards, as well as that reflected from the ground and buildings, can be clearly seen from space. Images from satellites give a good indication of the spatial distribution of light pollution. Figure 10 shows a light pollution map using satellite data from cloudless nights in 2015. The map clearly shows the most affected areas, which coincide well with the developed areas of Malta. The map also shows the upwards radiance component of sky glow due to the fact that areas over the sea are not completely dark.

Satellite data has also been used to establish trends and changes in light levels across the world. A recent study⁴ using calibrated satellite data has shown that Malta was in the fourth place among European counties in the percentage of land surface area increase in surface brightness when comparing the mean of 1995 – 2000 with 2005 – 2010. In comparison Slovenia decreased its percentage of land surface area brightness substantially. It is to be noted that Slovenia was the first European country to implement a national legislation against light pollution in 2007 (this law was actually based on the Lombardy Regional Law, 2000, aimed at fighting light pollution in the most populous and industrialised region in Italy).

Falchi et al. (2016)⁵ used satellite data together with ground-based measurements and light propagation calculations within the atmosphere to obtain a world atlas of artificial night sky brightness. While Figure 10 depicts the upwards flux of light as seen from space Figure 11 shows the zenithal artificial sky brightness as compared to the natural sky brightness from a European perspective. Further analysis per country reveals that Malta is in the 17th place worldwide, in terms of the most light polluted countries by population. About 42% of Malta's population is exposed to a night sky brighter than $3000\mu\text{cd}/\text{m}^2$, (micro candela per square metre) while the night sky for the remaining 58% is still between $688\mu\text{cd}/\text{m}^2$ and $3000\mu\text{cd}/\text{m}^2$ bright (natural background is assumed to be $174\mu\text{cd}/\text{m}^2$). Additionally, the Milky Way cannot be seen from 89% of the Maltese territory.

⁴ Bennie, J., Davies, T.W., Duffy, J.P., Inger, R. and Gaston, K.J. Contrasting trends in light pollution across Europe based on satellite observed night time light. *Scientific Reports*, 4:3789. DOI: 10-1038/srep03789, 1-6 (2014).

⁵ Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C.C.M, Elvidge, D., Baugh, K., Portnov, B.A., Rybnikova, N.A. and Furgoni, R. The new world atlas of artificial sky brightness. *Science Advances*, (2016, 2).

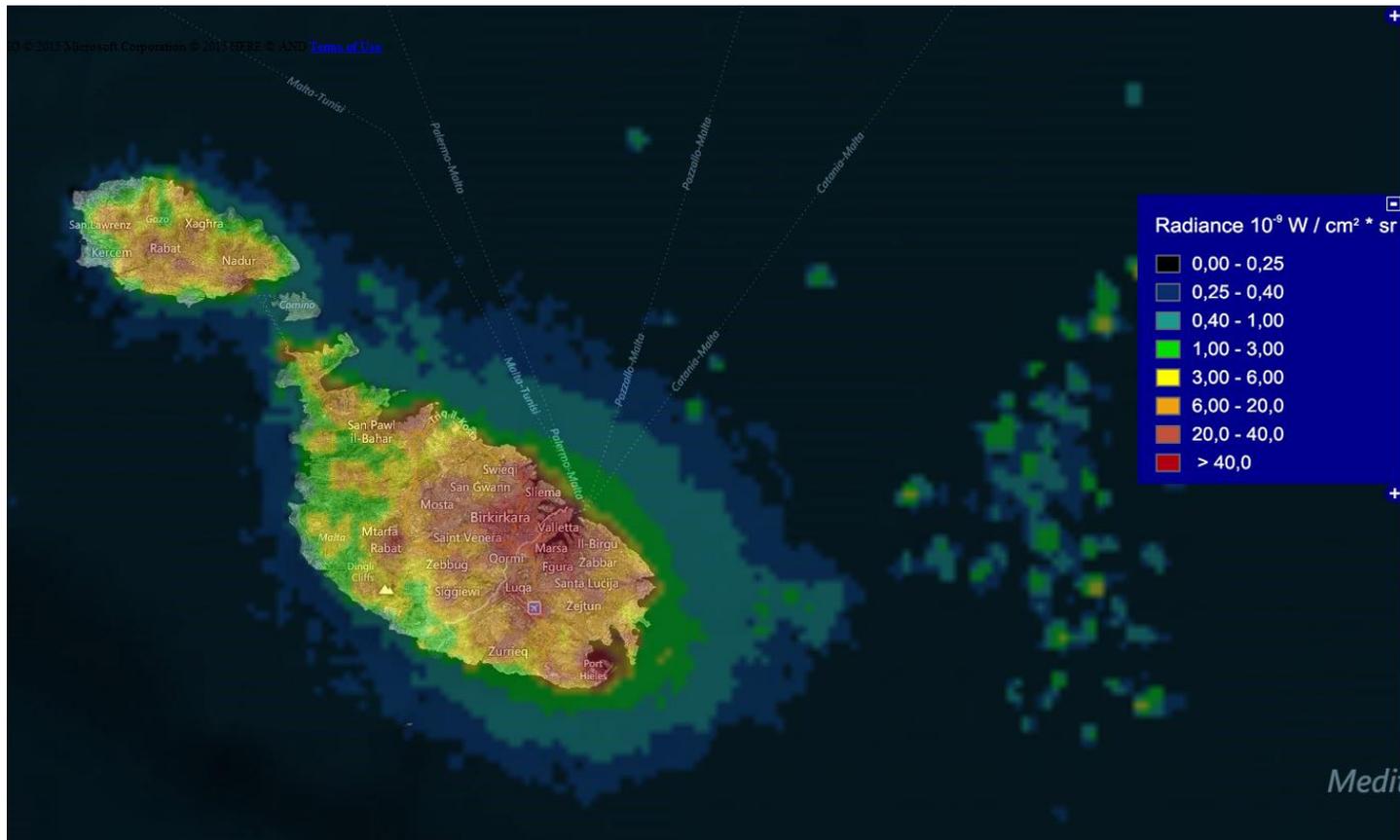
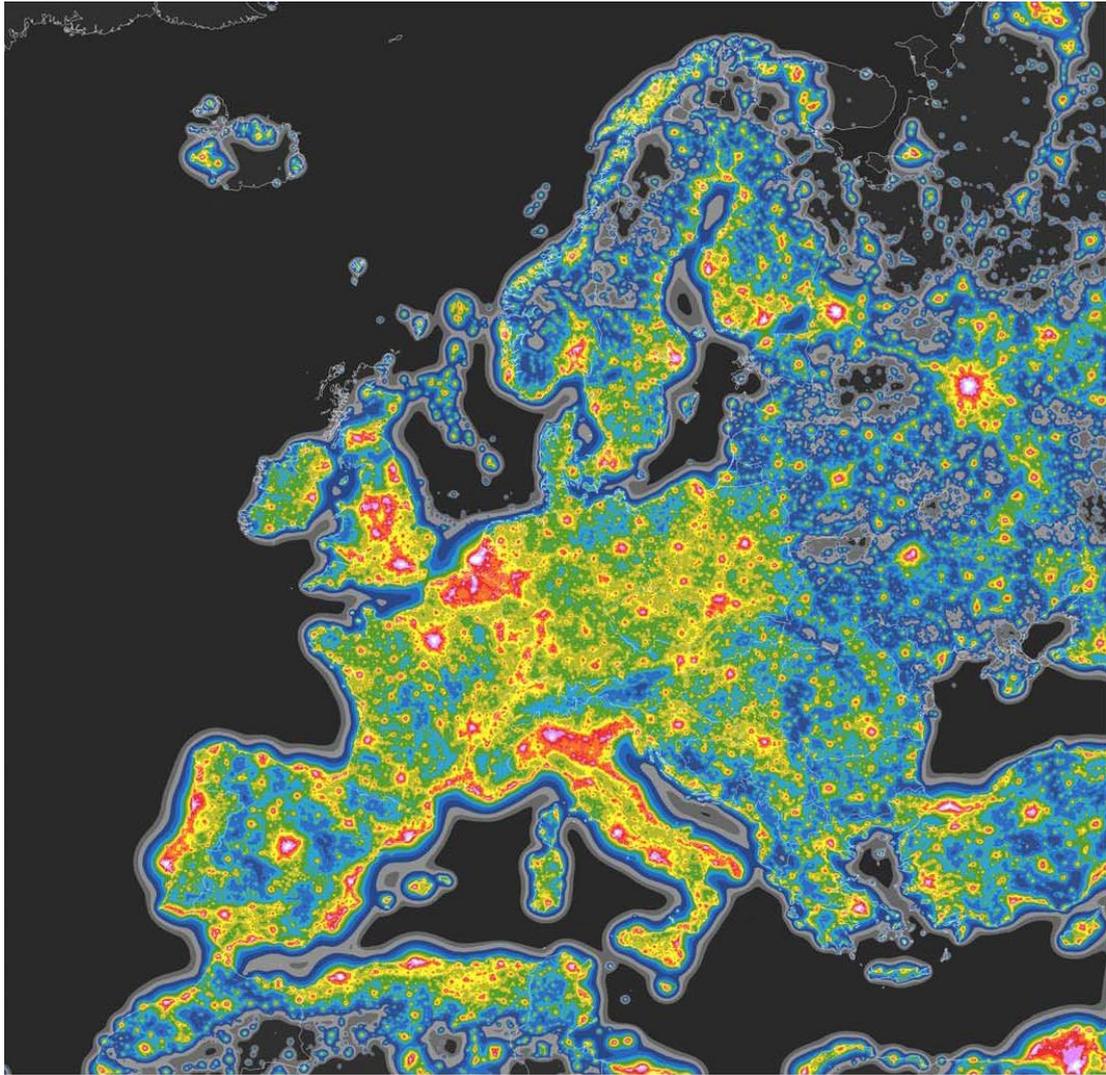


Figure 10: A light pollution map created from VIIRS DNB Cloud Free Composites data of 2015⁶. Dark blue are areas with low luminous intensity, red are bright areas with high luminous intensity

⁶ <http://www.lightpollutionmap.info/#zoom=10&lat=4290864.52673&lon=1576568.81879&layers=0BTFFFFTT>



Ratio to natural brightness	Artificial brightness ($\mu\text{cd}/\text{m}^2$)	Approximate total brightness (mcd/m^2)	Color	
<0.01	<1.74	<0.176	Black	
0.01–0.02	1.74–3.48	0.176–0.177	Dark gray	
>0.02–0.04	>3.48–6.96	>0.177–0.181	Gray	
>0.04–0.08	>6.96–13.9	>0.181–0.188	Dark blue	
>0.08–0.16	>13.9–27.8	>0.188–0.202	Blue	
>0.16–0.32	>27.8–55.7	>0.202–0.230	Light blue	
>0.32–0.64	>55.7–111	>0.230–0.285	Dark green	
>0.64–1.28	>111–223	>0.285–0.397	Green	
>1.28–2.56	>223–445	>0.397–0.619	Yellow	
>2.56–5.12	>445–890	>0.619–1.065	Orange	
>5.12–10.2	>890–1780	1.07–1.96	Red	
>10.2–20.5	>1780–3560	>1.96–3.74	Magenta	
>20.5–41	>3560–7130	>3.74–7.30	Pink	
>41	>7130	>7.30	White	

Figure 11: Europe's artificial sky brightness, in twofold increasing steps, as a ratio to the natural sky brightness (black = $174\mu\text{cd}/\text{m}^2$)

4. NEGATIVE IMPACTS OF LIGHT POLLUTION

Life on Earth has evolved on the natural cycle of day and night – a daily cycle of light and dark, also known as the circadian rhythm, which govern life-sustaining behaviours of all living organisms such as nourishment, sleep, reproduction as well as protection from predators. This section aims at outlining the known negative impacts of light pollution on living creatures.

4.1. Human Health

It has been scientifically proven that, in response to the circadian rhythm, the human body produces the hormone melatonin, which regulates our sleep and helps to keep the body in good health. Melatonin is produced by the pineal gland in the brain in response to darkness. Hence, exposure to artificial light at night suppresses melatonin production. Melatonin is also an antioxidant, therefore reduces the risk of cancer. The World Health Organisation has recognised research^{7,8} which suggests that the disruption of the circadian cycle by shift working is a potential carcinogenic trigger.

The disruption of the circadian rhythm can also result in sleep disorders^{9,10}, which manifest themselves in many ways, e.g. in:

- Weight gain,
- Stress,
- Depression,
- Onset of diabetes and
- Possible cancer.

It should be noted that light with shorter wavelengths has a stronger impact on the circadian rhythm and the suppression of the melatonin production as the respective receptors are most sensitive in this spectral range.

These detrimental effects on human health as well as the effects caused by glare on vision (see chapter 3.1) have been recognised by the American Medical Association¹¹, which adopted a guidance to reduce the harmful effects of high intensity and blue-rich street lighting.

⁷ Straif, K., Baan, R., Grosse, Y., Secretan, B., El Ghissassi, F., Bouvard, V., et al. Carcinogenicity of shift-work, painting, and fire-fighting. *Lancet Oncol*,8:1065-6 (2007).

⁸ Stevens, R. G., Brainard, G. C., Blask, D. E., Lockley, S. W. & Motta, M. E. Breast cancer and circadian disruption from electric lighting in the modern world. *CA: a cancer journal for clinicians* 64, 207–218 (2014).

⁹ Stevens, R. G., Brainard, G. C., Blask, D. E., Lockley, S. W. & Motta, M. E. Adverse health effects of nighttime lighting: comments on American Medical Association policy statement. *American Journal of Preventive Medicine* 45, 343–346 (2013).

¹⁰ Fonken, L. K. & Nelson, R. J. The effects of light at night on circadian clocks and metabolism. *Endocrine reviews* 35, 648–670 (2014).

¹¹ <http://www.ama-assn.org/ama/pub/news/news/2016/2016-06-14-community-guidance-street-lighting.page>

4.2. Crime and Safety

Recent comprehensive studies¹² have shown that there is little evidence that a decrease in the intensity of street lighting by means of dimming, part-night lighting or even switching off will lead to an increase in road collisions or crime. Notwithstanding the notion that lighting deters crime one may argue that lighting can actually decrease safety by making victims and property easier to observe¹³. Furthermore, it is known that vandalism and graffiti actually require artificial night lighting to be executed. In terms of artificial light, brighter does not necessarily mean safer. To give one example, glare from artificial light can decrease safety and create hazards since it shines into one's eyes and constricts the pupils to a blinding effect making it difficult for the eye to adjust to low-light conditions (refer to chapter 3.1).

Security experts recommend that a rapid change of the surrounding environment is most effective for the purposes of security. Infrared proximity and motion sensors (such as PIR sensors) connected to security lighting or alarms are the most effective solution for burglary prevention because when lights switch on suddenly they draw immediate attention from others. Moreover the sudden illumination tends to startle and confuse potential burglars and may deter them from proceeding with the burglary. Bright glaring lights that stay on all night long go unnoticed because most people who see someone approaching under those conditions usually believe the person belongs there.

In the interests of security, all security lighting should especially be designed to eliminate glare and direct view of illumination sources, and to confine illumination to the property on which the fixtures are located.



Figure 12 (source: www.elsevier.com/locate/jenvman): Increase in the intensity of light does not necessarily improve visibility

¹² Steinbach, R. et al., The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis, *J.Epidemiol Community Health*, doi: 10.1136/jech-2015-206012, 1-7 (2015)

¹³ <http://www.icjia.state.il.us/assets/pdf/ResearchReports/Chicago%20Alley%20Lighting%20Project.pdf>

4.3. Enjoyment of the Natural Night Sky

The continuing urban growth has led to uncontrolled outdoor lighting which has, in turn, hidden the night sky and changed our perception of the night. Experiencing the night sky is inspirational and adds to the well-being of mankind, which is why it is recognised as common heritage. Moreover, the night sky is instrumental in understanding the beauty of celestial features and mechanics through direct observation as opposed to inference only from books or electronic resources. For this reason, Dark Sky parks/reserves are being created around the world giving the opportunity to people, from densely urbanised areas, to enjoy the beauty of the natural night sky. This concept, if managed well, may also give rise to the opportunity to establish new tourism niches, given the number of cloudless nights that are normally experienced in our Islands. Back in the 18th century, the British astronomer William Lassell had built one of the larger observatories at the time in Malta in view of the number of clear nights and this led to a trend of locating astronomical observatories in locations with clear unobstructed skies.

4.4. Ecosystems and Biodiversity

There is no doubt that artificial light significantly alters the quality of the natural night sky. This negatively affects the daily natural light and dark rhythm of many living creatures by disrupting their environment and habitat.

Recent research has shown that even low levels of light at night have an impact on many organisms^{14 15}. As already mentioned above, all living organisms, have evolved under the natural rhythm of day and night. As brighter lighting extends further into rural areas, the distinction between day and night becomes less distinct. This often results in behavioural changes linked to the circadian cycle. Regular exposure to darkness as well as daylight, is, like in case of humans, essential to the health of diurnal animals.

Light pollution is a major threat to pelagic bird species such as the Scopoli's Shearwater (*iċ-ċiefa*) and the Yelkouan Shearwater (*il-garnija*), which Malta has a duty to protect under national and international law, including the EU Nature Directives. These birds are disoriented, are attracted to artificial lights in their night flights from their nests to the sea and ground further inland. In the worst cases these grounded hatchlings fall victim to predators, traffic or starve to death. Bright lights at sea close to breeding colonies also disturb the birds as they attempt to return to their nests at night to feed their chicks. Such disturbance can result in chick mortality if the adult seabirds are prevented from returning over a prolonged period of time. Studies have also shown how entire Shearwater colonies have been abandoned following the installation of lighting in the vicinity of their habitat¹⁶.

14 Hölker, F., Wolter, C., Perkin, E. K., & Tockner, K.. Light pollution as a biodiversity threat. *Trends in Ecology & Evolution*, 25(12), 681-682. (2010)

15 Gaston, K. J., Bennie, J., Davies, T. W. & Hopkins, J. The ecological impacts of night time light pollution: a mechanistic appraisal. *Biological Reviews* 88, 912–927 (2013).

16 Raine, H., Borg, J. J. et al. Light pollution and its effect on yelkouan shearwaters in Malta; causes and solutions. Malta: Life Project Yelkouan Shearwater. BirdLife Malta. (2007)

It shall also be mentioned that light pollution has a very detrimental effect on nocturnal migratory birds, including direct mortality (due to collisions with buildings and other structures caused by disability glare) and indirect negative effects such as the depletion of their energy reserves¹⁷.

A similar effect can be observed on turtles. Bright lights along the shorelines of sandy beaches may be preventing adult turtles from returning to shore during the breeding season, affecting key reproductive behaviours and strategies. The mortality rate of turtle hatchlings is reported as high due to light pollution. Once, the turtle hatchlings emerge from their nest, their instinctive behaviour is to find the fastest way into the sea in order to avoid land-based predators, orienting themselves on the brightness of the horizon, since under a natural sky, the horizon of the open sea is the brightest. Light pollution along the beaches and coastline disorients these hatchlings, which leads them to move inland instead to the sea.

Local studies have also highlighted the adverse effects of stray lighting, even at very low illuminance levels, on ground-dwelling arthropods¹⁸. Various animal species are attracted and “trapped” by artificial light sources. These insects eventually die and will be lost from the food chain and possible pollination of plants. Additionally they create maintenance issues by soiling luminaire covers and sometimes creating electrical problems.



Figure 13: Moths attracted and “trapped” by a luminaire
(Photos Left-M Nolle; right: <https://www.flickr.com/photos/dbgg1979/3421345648>)

Moreover, competing artificial lighting, particularly in rural areas, is considered having an adverse impact on various bioluminescent species, such as *Lampyris noctiluca* (Maltese: *musbieh il-lejl*). Light pollution is one of the factors affecting such species as it interferes with reproductive signalling and has been shown to impact the ability of males to locate light lures in competing lit environments¹⁹.

17 Poot, H., B. J. Ens, H. de Vries, M. A. H. Donners, M. R. Wernand, and J. M. Marquenie. Green light for nocturnally migrating birds. *Ecology and Society* 13(2): 47 (2008)

18 Brincat S.M.; Ground dwelling arthropods and light pollution: implications for conservation areas in the Maltese Islands. Unpublished dissertation, University of Malta (2014)

19 Bird, Stephanie and Parker, Joel; Low levels of light pollution may block male glow-worm’s (*Lampyris noctiluca* L.) ability to locate females; *Journal of Insect Conservation*. (2011)

However, the effects of light pollution on various animal species is diverse and not always obviously negative. So it has been observed that animals adapt to the current conditions by changing their feeding and roosting patterns due to the presence of artificial light²⁰. For instance, some species of pipistrelles, *Pipistrellus* spp. (Malt.: *il-pipistrell*) are known to take advantage of the food abundance around light sources due to the attracted insects and have the advantage over other type of bats. On the other hand, bats (Malt.: *friefet il-lejl*), like the lesser horseshoe bat, *Rhinolophus hipposideros* or the Maghrebian mouse-eared bat, *Myotis blythi punicus*, require dark hunting areas and show a flight-of-light behaviour. A shift in biodiversity is the consequence²¹.

As in the case of human health, there is growing evidence that most detrimental effects of light at night increase when the light contains a high amount of blue content (shorter wavelengths, higher colour temperature). Hence there is a need for the reduction in the colour temperature of high intensity light sources which should not exceed 3000K (Kelvin).

4.5. Waste of Energy

Over-illumination, light spilled into areas where it is not needed as well as illumination throughout the entire night are a waste of valuable energy. Wasting energy has huge economic and environmental consequences which contribute considerably to climate change. This is especially relevant to island countries, like Malta, as they are particularly vulnerable to climate change²². On the other hand, quality lighting design reduces energy use and therefore reduces carbon emissions thus saving taxpayers' money on two counts - by reducing electrical consumption and funds required to address greenhouse gas issues). Currently, public and private lighting contributes to about 2.5% of total electricity consumption. In comparison to this the amount of renewable energy produced in Malta in 2016 stood at 5.6 %.

Irrespective of how efficient the used luminaires are, over-illumination and light spill are always a waste of energy. Unfortunately, the current trend of converting existing lighting installations to LED lamps has not resulted in the desired reduction of over-illumination and light spill and there is therefore room for further reduction of waste of energy through proper lighting design. An analogy is filling a glass of water. Overfilling a glass of water always results in spill and wastage. Therefore the ideal to be pursued is to properly illuminate an area only with the necessary amount of light.

The following Figure 14 shows how the city centre of Milan became brighter after the conversion to bright white LED streetlights.

20 Byron B.,;A look at the Chiropteran Fauna of the Maltese Islands: Towards an effective Action Plan for their conservation. Xjenz 12. (2007).

21 Patriarca E., Debernardi P.; Bats and light pollution. (2010)

22 <http://mra.org.mt/climate-change/adaptation-to-climate-change/>



Figure 14: Milan at night in 2012 (top) and in 2015 (bottom) after the conversion of its streetlights to LED²³

²³ <http://www.techinsider.io/astronaut-photos-light-polution-led-nasa-esa-2015-8>

5. LEGAL AND POLICY FRAMEWORK

The legal and policy framework is mostly shared between the Planning Authority (PA) and the Environment and Resources Authority (ERA), through various aspects of the Development Planning Act (Cap. 552) and the Environment Protection Act (Cap. 549).

5.1. Strategic Plan for Environment and Development (SPED)

“To safeguard and enhance biodiversity and cultural heritage”, Thematic Objective 8.9 of the SPED aims at *“Controlling sources of light pollution which negatively affect the rural area.”*

5.2. The Environment Protection Act, 2015 Part VI, Article 58

The negative impacts that artificial light may have on species and ecologically sensitive areas is acknowledged by the *Act* and requires authorisation from the Environment and Resources Authority (ERA) for activities or operations which generate light pollution. This provided (article 59) it is not an activity for which an authorisation is given in an order.

5.3. The National Environment Policy (NEP) and the National Strategy for the Environment (NSFE)

The National Environment Policy is comprehensive in scope, covering all environment sectors and lays down the principles upon which Malta’s environment will be managed and upgraded, and which other non-environmental sectors must respect and adhere to, taking into account all existing national, European and multinational obligations, but is not restricted to these matters.

In relation to light pollution, the NEP has measures aimed at the better integration of environmental considerations in activities that affect the rural environment, citing protection of the countryside from inappropriate development, including that giving rise to light pollution, as well policies ensuring that representative species and ecosystems are given adequate protection, and that wildlife corridors, buffer zones and stepping stones interlinking landscape matrices, habitats or protected areas are established and maintained, adding that “such areas will also be protected from infrastructure and development giving rise to light pollution”.

It should be noted that in line with the Environment Protection Act (Cap. 549), the ERA is preparing the National Strategy for the Environment (NSFE), which is a strategic governance document to be adopted by the House of Representatives. This Strategy will set the policy framework for the preparation of plans, policies and programs issued under Environment Protection Act (Cap. 549) or under any other Act for the protection and sustainable management of the environment, including land and sea resources.

In preparing such NSFE, the following are also to be addressed:

- environmental policies;
- the State of the Environment Reports as produced by ERA in line with the Environment Protection Act (Cap. 549);
- the current economic and financial policies;
- the current social policies;
- the policies of the Government;
- the environmental issues and concerns of material relevance to the strategy, which would also include light pollution and related matters;
- the resources likely to be available in all relevant government entities for the implementation of the Strategy; and
- the European Union Environment *Acquis* and other international environmental agreements to which Malta is a party.

5.4. The National Biodiversity Strategy and Action Plan 2012-2020 (NBSAP)

Malta's National Biodiversity Strategy and Action Plan 2012-2020 (NBSAP), as adopted under the Environment Protection Act (Cap. 549), includes various targets and measures aimed at securing progress in halting biodiversity loss by 2020 and to place it on a course of recovery. Some of the targets address both direct pressures and underlying causes of biodiversity loss, whilst other address a number of other targets are aimed at improving the status of Malta's biodiversity and enhancing the benefits from biodiversity and associated life supporting services. In this respect, Target 8 has the objective of implementing effective measures to address pollution in line with the requirements of established legislation, showing signs of a decreasing trend in current pollution levels, where feasible.

5.5. The Flora, Fauna and Natural Habitats Protection Regulations (SL 549.44)

The Flora, Fauna and Natural Habitats Protection Regulations, 2006 (FFNHPR, SL 549.44), which requires that applications affecting protected areas and protected species to be pre-screened by the ERA. In this respect, four general mechanisms are in place, which are applicable to both development and non-development aspects, which are the following:

- **Management Plans, Management Agreements and Conservation Orders.** Various management plans, management agreements and conservation orders have been enacted or adopted under the FFNHPR, on the basis of Regulations 15-17, which also include provisions involving impacts within protected sites and affecting protected species and other biodiversity of importance. These also include issues linked with disturbance, such as light pollution.
- **Activity Permitting,** as regulated through a notification-authorisation system which requires prospective applicants to notify ERA, Regulation 18 of the Legal Notice poses restrictions on operations and activities which are envisaged to have an impact on biodiversity, thus including lighting, particularly in rural areas, where most protected areas under the National Ecological Network are located.

ERA is to notify the applicant of its consent or otherwise for the carrying out of such operation or activity.

- **Appropriate Assessments.** Where it appears to ERA that an application for consent under the FFNHPR relates to an operation or activity which is or forms part of a plan or project which is not directly connected with or necessary to the management of a protected site, and is likely to have a significant effect thereon, either individually or in combination with other plans or projects, ERA “*shall make, or require the applicant to make, an appropriate assessment, of the implications of the operation or activity on the site in view of the site’s conservation objectives*”, Regulation 19(1). ERA may give consent to the operation or activity only after having ascertained that the plan or project will not adversely affect the integrity of the site concerned and if appropriate, after having obtained and taken into account the opinion of the general public and representations made within such reasonable time as the competent authority may specify.
- **Species Protection, Nature Permitting and Derogations.** Parts IV and XI of the FFNHPR protect various threatened and/or endemic species nationwide, and include prohibitions impacting their biological life cycle, including disturbance. Such disturbance also includes such aspects during the periods of breeding, rearing, hibernation and migration. Activities like artificial lighting, particularly in rural areas, have to take in consideration this aspect – indeed a permitting and derogation process is established to control and mitigate such disturbances. A nature permitting system is as such set up in Regulations 43-46, which also include provisions on derogations to international law such as the EU Habitats Directive and various multilateral environmental agreements under the Council of Europe (COE) and United Nations (UN), implemented through these Regulations.

5.6. Environmental Assessment

Light Pollution is an environmental issue taken into consideration during ERA’s environmental screening process of applications, as relevant depending on the location of the proposal and the case-relevance of the light pollution impact. Development proposals and other plans and projects falling under subsidiary legislation of the Environment Protection Act (Cap. 549) may even require other types of environmental assessments, including an Environmental Impact Assessment (EIA) screening procedure of projects in terms of the EIA regulations, 2007 (SL 549.46) and/or an Appropriate Assessment procedure under Regulation 20 of Flora, Fauna and Natural Habitats Protection Regulations (S.L.549.44) in view of their impacts on Special Areas of Conservations (SAC) and Special Protection Areas (SPA).

5.7. The Marine Policy Framework Regulations (SL 549.62)

The Marine Policy Framework Regulations (SL 549.62) establish a framework within which Malta is to take all the necessary measures to achieve or maintain good environmental status in the marine environment by 2020. ERA as the entity providing technical assistance on this matter, developed an Integrated Marine Monitoring

Programme under Regulation 9 and a Programme of Measures under Regulation 10 of these Regulations. The latter Programme of Measures also address light pollution and include measures aimed at the establishment of appropriate codes of conduct addressing all forms of disturbance (including light) within terrestrial protected areas affecting selected species (particularly measures related to seabirds, marine reptiles and mammals). In addition, measures linked with the preparation of official guidance documents aimed at providing direction with respect to reduction, control and mitigation of light and noise pressures driven by both land-based and sea-based activities and related awareness and educational campaigns targeting such disturbance issues in recreational areas are also included.

5.8. Development Control Design Policy, Guidance and Standards 2015 (DC 2015)

Good Practice Guidance G27 aims at preventing light pollution by requesting that:

Any proposed development or redevelopment should not be a source of light pollution. To this effect:

- a) *lighting should be strictly limited to within the developed part of the site and should direct light only where the light is required and only when the light is needed;*
- b) *the development should not be considered as a justification for the lighting of the access roads, tracks and paths leading to the site or other lighting beyond the site boundary;*
- c) *the lighting should be from any peripheral landscaping inward, so as to be screened as much as possible by the landscaping itself; and*
- d) *with the exception of architectural lighting on historic structures, all exterior lighting installed on site should be of the downward-pointing, full cut-off type which when installed at the specified design attitude gives zero intensity at and above the horizontal. No luminaire globes or up-lighters would be accepted.*

Any development planning application, particularly related to historical structures, which includes architectural lighting, is to be accompanied by a lighting scheme report endorsed by an independent Warranted Engineer certifying that the proposed lighting will minimise light pollution.

Any lighting installation, including the external lighting of buildings, structures and roads, may require an ERA permit and/or written endorsement when proposed within protected areas designated under environment legislation, or within 30 metres of the boundaries of such areas, or where the lighting affect protected areas or species.

5.9. The Development Notification Order (Legal Notice 211/16)

The DNO recognises that artificial lighting is classified as development, albeit permitted, provided it is not within a UCA, ODZ or within 30 metres of a scheduled property. In such cases, a notification in line with the DNO procedures would be

required. It also goes on and states where such lighting is not permitted. The full text of the relative class in the DNO is being reproduced below.

CLASS 12

Lighting of buildings, structures and roads

- (i) *the external lighting of buildings, structures and roads provided that the development is not permitted where:*
 - (a) *it is incompatible with the character of the location and/or create unacceptable light pollution; or*
 - (b) *in the case of street lighting ODZ, involves lighting beyond the street itself and/or cause unacceptable light pollution in an area that should be kept free from artificial nocturnal lighting or compromise the conservation of important flora, fauna or ecosystems;*
 - (c) *it involves the illumination of any sign or advertisement, or such illumination constitutes its primary purpose; or*
 - (d) *it involves an area larger than a building or structure;*
 - (e) *it involves a scheduled property.*

For the purposes of this Class, temporary lighting of buildings and structures, for festivities and similar events, shall not be deemed to constitute development.

Development under this Class, where the site or lighting equipment of buildings and structures lies in a UCA or ODZ or in a designated area or in or within 30 metres of a scheduled property, shall be subject to the notification procedure established in regulations 5(1) and 5(3).

5.10. Site Specific Policies

Various site-related policies under both the Development Planning Act (Cap. 552) and Environment Protection Act (Cap. 549) include specific provisions addressing directly or indirectly light pollution or related aspects affecting biodiversity or human health.

The Natura 2000 Management Plans and Conservation Orders include various provisions which are relevant to impacts on biodiversity. Such plans relate to terrestrial protected areas and are available at <https://era.org.mt/en/Pages/Natura-2000-Management-Planning.aspx>.

The Gozo and Comino Local Plan has introduced two site specific policies to control nocturnal illumination and combat light pollution:

Policy GZ-UTIL-5:

MEPA will request that proposals including outdoor illumination will have luminaries which are energy efficient and have an Upward Light Ratio of 0%. MEPA will also request that low-wattage, low level lighting is employed in public gardens and that in environmentally sensitive areas (e.g. scheduled areas or sites, valleys, ridge edges), external artificial illumination levels should be kept to the barest minimum (refer to policy GZ-DARK-1).

Policy GZ-DARK-1:

The areas shown in MAP 13.8 (refer to Figure 15) shall be designated as Dark Sky Heritage Areas. Where relevant, reflective signs shall be employed to guide driving at night, whilst the installation of lighting which is not related to aerial or maritime navigation, shall be strongly discouraged.

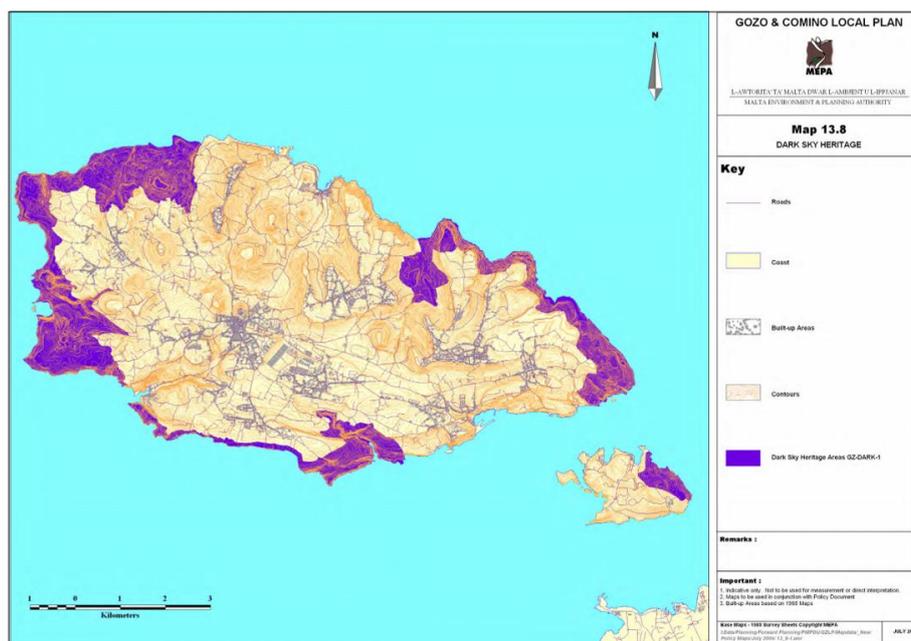


Figure 15: Dark Sky Heritage Map of the Gozo and Comino Local Plan

5.11. Other Applicable Legislation

Various other legislation and policies, particularly under the Environment Protection Act (Cap. 549), address light pollution issues indirectly.

The Fungus Rock (il-Ġebbla tal-Ġeneral) Nature Reserve Regulations (SL 549.01) and Selmunett (St Paul's Islands) Nature Reserve Regulations (SL 549.03) prohibit access to the islands or parts thereof, and protected the flora and fauna of the islands, consequently addressing issues linked with installation of artificial light in prohibited areas). A permitting system, administered by ERA, is in place.

Similarly, permitting systems are set up under ERA through the Reptiles (Protection) Regulations (SL 549.02), the Marine Mammal Protection Regulations (SL 549.35) and the Trees and Woodlands Protection Regulations (SL 549.64).

Additional provisions related to wild birds and disturbance are also provided by the Conservation of Wild Birds Regulations, 2006 (SL 549.42).

6. GUIDELINES

6.1. General Principles

In order to gain most benefits from an external lighting installation, the most efficient and well-designed luminaires should be installed. Lighting installations should be thought of at design stage, fitted according to specification, be well-maintained and only the amount of light necessary for the purpose should be used.

Artificial light should:

- Only be switched on when needed
- Only illuminate the intended area, without overspill
- Be no brighter than necessary
- Minimize blue light emissions (colour temperature not higher than 3000K)

6.2. Using well-designed lighting only when required

A significant amount of energy is consumed and vast amounts of greenhouse gases are produced due to the wastefulness of all-night lighting such as shop advertising and display lighting, building illumination, upward floodlighting, unused lighting of sports facilities and permanent domestic, industrial or other security lights. Consideration should be given to the energy efficiency of fittings and a strong lighting management policy should be in place in large establishments to reduce running costs and promote sustainability. Installing well-designed lighting systems saves money and conserves energy.

In areas with very little activity in the late hours it is generally recommended to reduce the intensity of all non-essential light sources to values below 50% of their initial intensity. It may also be practical to completely switch off all artificial light when the site in question does not present any safety hazard. This is an essential practice to save energy. Over-illumination should be avoided by not exceeding the minimum illuminance levels recommended by international standards (such as CIE, CIBSE etc.).

In residential and other development which require outdoor lighting for safety and security reasons, one should strongly consider the installation of motion sensors to operate the light fittings only during periods of activity and intrusion. As previously indicated, such installations are not only economically viable but are also more effective in terms of security.

Airports around the world have been employing switching off or dimming techniques for many years. Runways are to be fully illuminated only when required and are guided by international documentation such as the Aerodrome Design Manual by the International Civil Aviation Organisation. Where lighting is continuously required for 24-hour operational facilities (e.g. port terminals or aircraft aprons) horizontal cut-off techniques and well-designed luminaires often translate into good light pollution reducing measures and constitute significant cost savings to the operator.

6.3. No direct emission to the sky

This can only be done if there is no light output at and above the horizontal. The choice of light fittings and their installation should ensure that no light is emitted above the horizontal plane. This can be easily achieved by using fully-shielded fixtures. These measures are very effective to curb light pollution subject to proper installation and correct lighting intensities being used.

Where this is not possible (e.g. indirect architectural illumination) the lighting should be well-designed and directed to the desired area with the least possible light overspill.



Figure 16 (Photos M Nolle); An old semi cut-off lamp (top) emits a significant amount of light above the horizontal. It was replaced by a full cut-off lamp (below) resulting in 0% direct emission to the sky

6.4. Colour Temperature

The use of ‘cool white’ light sources with a high colour temperature should be avoided. Nowadays ‘warmer white’ sources reach the same efficacy levels as the blue-rich sources but with a much lower environmental impact. On the basis of scientific evidence, highlighted earlier in this document, it is essential that any sources of light intended for exterior illumination should have a correlated colour temperature not higher than 3000K.

6.5. Lighting for Security

Lights should be dimmed or, better still, switched off when not required for safety or security reasons. This method is known to result in very significant cost savings and prove to be a more effective security-related deterrent. The principle is equally relevant in most outdoor lighting environment - whether domestic, commercial, industrial or infrastructural. Intrusion-triggered lighting is especially effective around infrastructural installations as these rarely require to be illuminated at night (perhaps except for aviation navigation related lighting).

6.6. Searchlights and lasers

High intensity searchlights or lasers pointing into the sky, as a means of publicity or entertainment, are sufficiently intense to be seen at night as beams or to light up clouds. They are a cause of distraction and may constitute a driving and aviation hazard and indeed may qualify as ‘dangerous lights’ in accordance with the Air Navigation Order SL 499/09. Moreover, in view of the required power, they are considered to cause an unnecessary wastage of power and may cause nuisance to third parties. Therefore, such installations should be avoided.

6.7. Design and Planning of lighting installations

It is possible to reduce many of the negative effects of lighting through careful design and planning, using lighting only where and when necessary, using an appropriate intensity of light and adjusting light fittings to direct the light to where it is required. Illumination should be appropriate to the surroundings and character of the area, as a whole, while excessive lighting should be avoided.

The illustration below provides an easy visual guide to understand the differences between inappropriate, unshielded external light fixtures and those fully shielded fixtures that minimize sky glow, glare and light trespass.

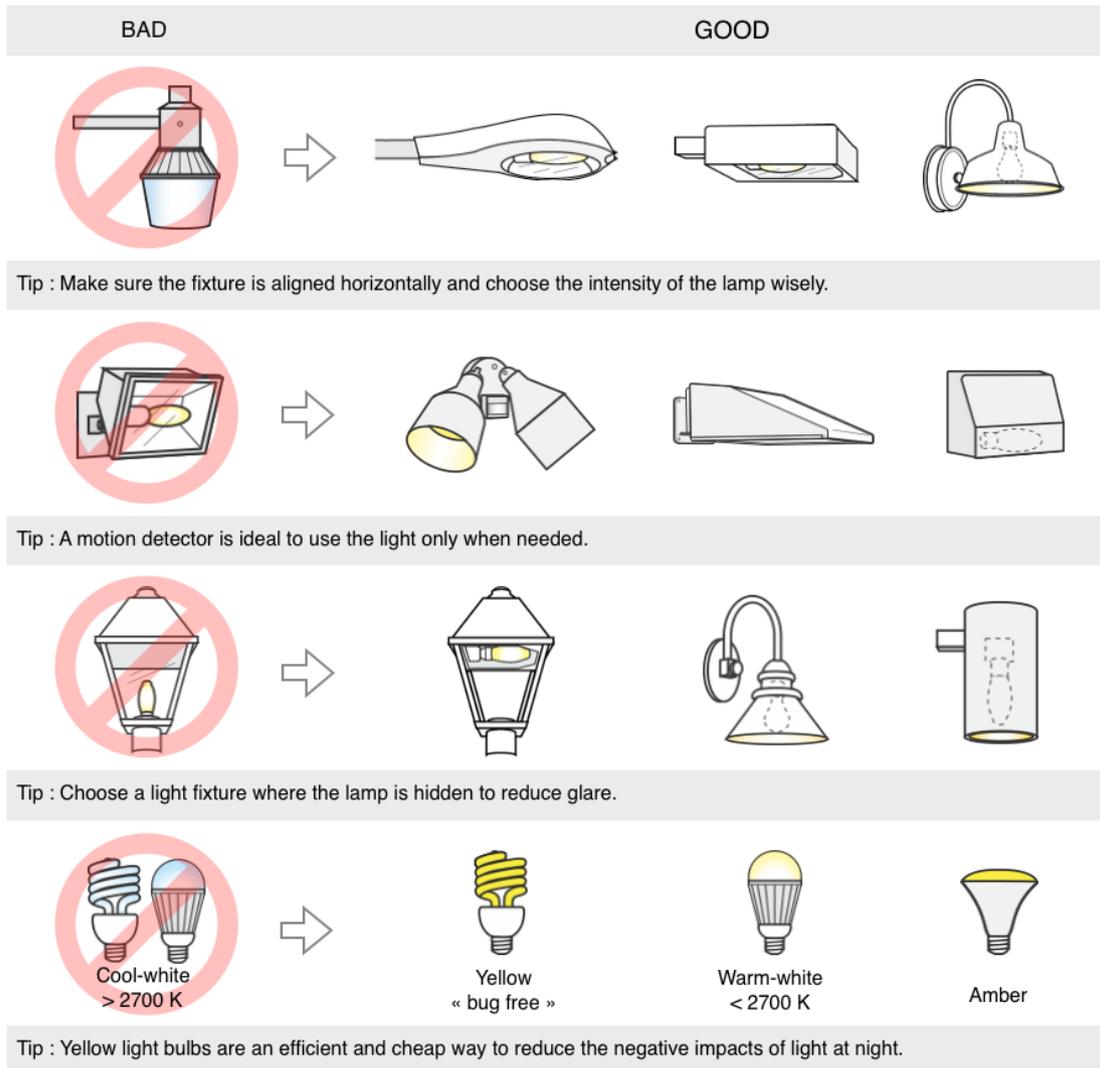


Figure 17: Examples of good and bad lighting fixtures
<http://ricemm.org/en/documentations/recommended-fixtures>

Existing installations which are not compliant to the measures proposed in this document may have external metal shields fitted. This could be an equally effective and cheaper solution, rather than changing the lamp, to eliminate the spread of light above the horizontal.



Figure 18 (photos M. Nolle): Two examples of simple inexpensive light pollution mitigation measures on existing floodlighting. Left: Adjustable “barn doors” on floodlights for the illumination of a church facade. Right: Homemade shield out of galvanised sheet metal for a floodlight at a farm located ODZ

6.8. Outdoor Lighting in the ODZ areas and in Large Development

Choices made by various jurisdictions about outdoor lighting impact all species and are especially important for locations in or near sensitive habitats. Bad lighting practices can have lethal consequences for wildlife, but good policies can actually help restore healthy ecosystems. Hence, the installation of external lighting in rural areas and buffer zones are particularly sensitive due to the above-mentioned reasons. The lighting installation, whether this is carried out on its own or as part of a larger project, shall be regarded as development for which a development permit would be required. Moreover, different environmental permits would also be required in line with legislation cited in Section 5 of these guidelines. This shall include lighting to be installed in:

- 1) All development located Outside Development Zone (including residential, tourism related and agricultural development)
- 2) Industrial and commercial development, including all industrial parks and storage facilities, fuel service stations, airports and ports
- 3) Road construction/upgrading and ‘open’ parking areas
- 4) Sport facilities, public gardens and playing areas
- 5) Architectural illumination (including church domes and building facades)

For such illumination projects, a lighting scheme report endorsed by an independent warranted engineer would be required with the relative development permit application. The report should include:

- a) A statement indicating why a lighting scheme is required as well as the planned times of operation;
- b) Details of the luminaries, including their type, location and height above the ground;
- c) Technical data sheets (manufacturer catalogue extracts) of the luminaries, including polar emission diagrams and a description of what measures will be implemented to minimise and mitigate light pollution; and
- d) Where required, a plan illustrating predicted illuminance levels across the site and at the boundary of the property.

The external lighting scheme report would eventually be a supporting document with the development permit and backed by a condition to ensure the implementation of the lighting scheme, as approved.

6.9. External Lighting in Urban Areas

Nature is all around us whether we live in urban or rural settings. It is therefore a misconception that additional light installation within the already lit urban environment will not have a negative impact. Increased light levels will unquestionably lead to increased sky glow while light intrusion into our houses and bedrooms poses an increased health risk and a nuisance, reducing the quality of life. Outdoor lighting within the urban development should therefore also be controlled.

One must also give due consideration to the type, design and also the actual location of development. For instance, high rise buildings and large, glazed apertures can easily give rise to undesired light trespass. Likewise, the negative effect of light pollution from development on the fringe of the urban boundaries is likely to intensify due to light trespass also onto the rural area.

Thus, a development planning application related to medium or high rise buildings (having a height which exceeds the designated height limitation of the area in which it is located); commercial/industrial development with large shop windows and outdoor servicing and parking areas should be accompanied by a lighting scheme report, as outlined in section 6.9.

Given that most development is likely to include some sort of outdoor lighting, such as in backyards, internal yards, terraces and/or on the façade, all development permits shall be accompanied by a condition which reads:

The development is not to be a source of light pollution. To this effect:

- (i) Lighting should be strictly limited to within the developed part of the site;*
- (ii) All exterior lighting installed on site is to be of the downward-pointing, full cut-off type. No luminaire globes or uplighters are to be installed;*
- (iii) The colour temperature shall not exceed 3000K,*

The following conditions may also be included depending of the type of development being approved

(iv) the development hereby being permitted should not be considered as a justification for the lighting of the access roads, tracks and paths leading to the site or other lighting beyond the site boundary;

(v) the lighting has to be from any peripheral landscaping inward, so as to be screened as much as possible by the landscaping itself.

(vi) any development at the edge of the Urban Area, or adjacent to protected sites should not be a source of light pollution towards the rural/marine/protected environment. Street or other outdoor lighting (if any) shall be low-key, downward pointing, and of a full cut-off type. No luminaire globes, up-lighters or floodlighting which contribute to light spill are to be fitted. There shall be no illumination of any ODZ land near/adjacent to the site.

The European Norm document *EN 12464-2:2014 Lighting of work places - Outdoor work places*, establishes the minimum illuminance levels for different situations and applications:

6.10. Street Lighting

In recent years we have experienced an improvement in terms of light pollution from street lighting particularly in major road network projects. Full cut-off lights are being used while, in some cases, the dimming of the light source during low activity hours is also being carried out. Nonetheless, street lighting and lighting of areas used by vehicles remains one of the main sources of light pollution.

The illuminance levels of roads, yards, parking areas, pavements and other open areas should not exceed the minimum requirements of the European Norm document EN 13201-1:2014 Road lighting - Parts 1- 4.

There is also no need to illuminate roads or parking areas with the maximum luminance throughout the entire night as traffic flows and activity tend to decrease significantly as the night matures, depending on the locality and type (hierarchy) of road. Hence, a variable lighting level system should be implemented. This could be done by partially switching off non-dimmable luminaries or dimming of dimmable luminaries, such as LED lamps.

Full cut-off fixtures should also be installed in all situations and fitted horizontally in accordance with the manufacturer's specifications. Decorative and 'traditional-style' fittings and poles can also accommodate full cut-off arrangements. Furthermore, unless otherwise required for road safety reasons, these should have a colour temperature not exceeding 3000K.

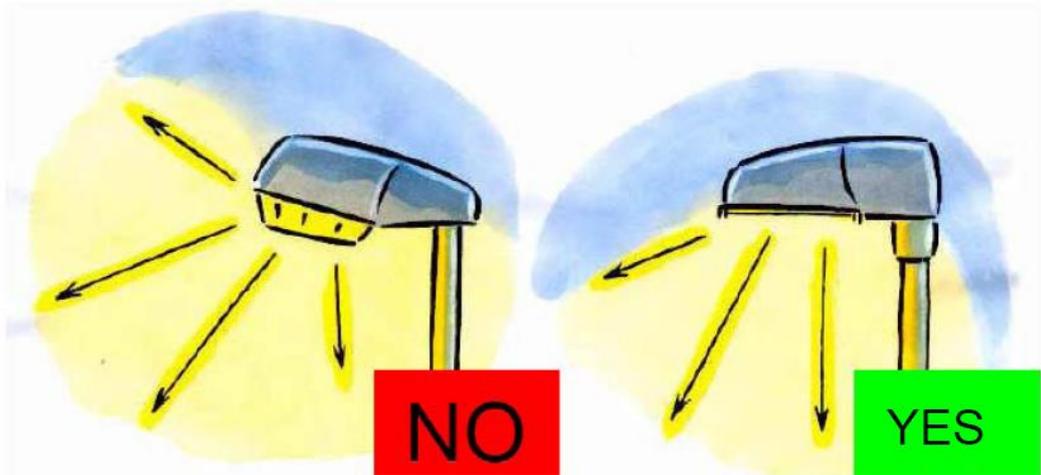


Figure 20: Common street lighting fixtures (CieloBuiro)



Figure 21: Traditional-style fittings (CieloBuiro)

6.10.1 Alternatives to Road Lighting

Especially in rural areas, preference should be given to passive means of warnings to drivers and pedestrians. These include the installation of retroreflective road markers (cats' eyes), retroreflective line markings or informational signs and other reflectors as may be recommended and deemed acceptable by local standards and regulations. In some cases, depending on the configuration of the road, road classification, frequency

of use etc., the use of these accessories and other traffic management measures eliminate the need for the use of artificial lighting. However, consultations with the competent authorities responsible for road safety are advisable.

6.11. Outdoor Recreation Areas and Sports Lighting

In an attempt to enable more people to participate and give more choice and flexibility of recreation time, it is increasingly common for sports clubs and schools to install floodlighting to their facilities (football, tennis, hockey pitches, playgrounds etc.).

Unless the right type of fittings are designed and installed, these are/will be a source of light pollution and nuisance especially when located close to residential areas. There are a number of such facilities which already provide shielded lighting, however the large majority of sport lighting installations in Malta create large amounts of skyglow and glare.

Thus, in such sites, all floodlighting shall consist of flat glass full cut-off asymmetric floodlights fitted with louvers where required and mounted horizontally such that no light is allowed above the horizontal. Lighting fixtures should also be mounted and aimed so that as little direct illumination as possible is directed off the site.



Figure 22: Sports ground lit using full cut-off asymmetric fittings
(<http://www.amsky.com/observing/lp/lp.html>)

The retrofitting of the existing installations is highly encouraged, such as the fitting of metal shields to avoid upward illumination and restricting the main beam angle of the lights so as to reduce the direct illumination of areas beyond the facility. This would also be of a benefit to the users as it will increase the illuminance at ground level due to the percentage of light which beforehand went wasted into the sky. The change to fully shielded ones is also required when the existing polluting fittings are replaced.



Figure 23 (photo M.Nolle): An example of retrofitting of the existing installations by shielding of floodlights in a sports complex

6.12. Architectural Lighting of Buildings and Monuments

The main principle to keep in mind when considering the illumination of buildings is that the emission of light above the horizontal serves no real purpose and should be minimised as much as possible to eliminate light pollution.

From an architectural point of view, highlighting specific features rather than flooding an entire facade with light makes much more sense. Thus, lighting on buildings and monuments should be very subtle and sensitive to the surroundings. Use (a) the right amount of light (b) where needed and (c) when it is needed.

Examples of good practice:

1. The average luminance on the façade or monument is not to exceed $1\text{cd}/\text{m}^2$. (roughly an illuminance of not more than 10 lux when measured at the surface);
2. The illumination should only go up to the cornice or up to 1 metre below the topmost part of the structure (normally the roof level parapet wall);
3. The façade should preferably be lit from nearby roofs/light poles using circular spotlights fitted with glare shields and baffles;
4. Choose fittings which can be easily directed and controlled rather than large floodlights which are meant to illuminate large areas;

5. Use technology to one's advantage. Linear LED light fixtures are very small and invisible during daytime. These can be mounted underneath copings and cornices, aimed downwards thereby serving also to illuminate the ground below. They should be fitted with cowls to restrict the illumination only onto the façade;
6. All architectural, façade and decorative lighting should be switched off at 11p.m.

Examples of bad practice:

- 1 Lighting from below. This also gives rise to light spill onto neighbouring properties while emphasises dramatic upward shadows rendering the whole façade grotesque.
- 2 Use of ground-recessed uplighters. Their maintenance is a lifetime issue mainly due to condensation and corrosion, but worst of all, over 90% of the light misses the facade or object they intend to light.

6.13. Warning Lights

Aviation/aircraft warning lights on tall buildings and structures shall not consist of flashing white strobe lights (unless for daytime use only) but low-intensity red warning lights should be utilized (ICAO Annex 14 Type B for example) as requested and permitted by relevant authorities (one may also refer also to Air Navigation Order SL 499/09).

6.14. Billboards and Signs

Billboards and signs are intended to attract attention and are normally placed on very prominent locations most of which are, in some way or another, illuminated. There are three main types of illuminated billboards. Internally illuminated, externally illuminated and LED. All types give rise to some degree of light pollution but the most damaging are the LED billboards which not only give rise to glare but are also a safety hazard to motorists and pedestrians due to their sudden change in content and intensity of light.

For these reasons:

1. The brightness of all LED billboards should be reduced considerably on sundown. The night-time luminance should not exceed 100 cd/m².
2. All illuminated billboards located along the road network should be switched off at 11 p.m. (this does not apply to traffic related information signs)
3. All signage on commercial buildings should be switched off when the premises are not in operation.

7. DESIGNATION OF DARK SKY HERITAGE AREAS

Designating a site as Dark Sky Heritage areas implies that the installation of lighting would be strongly discouraged. The lighting allowed should be only related to aerial or maritime navigation, and reflective signs shall be employed to guide driving at night.

In the islands of Gozo and Comino, some protected sites fall within the designated Dark Sky Heritage Areas, as identified in the Gozo and Comino Local Plan. On the other hand, albeit Figure 10 shows that there are still some relatively dark areas along the western and north-western coast of the Maltese main island, these areas are currently not designated and controlled as Dark Sky Heritage Areas. Whereas protected sites in Gozo and Comino fall within the designated Dark Sky Heritage Areas, as identified in the Gozo and Comino Local Plan. Thus, there is the need of protecting the night sky in these areas from further deterioration.

A number of locations have been designated as protected areas for nature and biodiversity conservation under the Environment Protection Act (Cap. 549). Additional protection is also provided to sites forming part of the EU's Natura 2000 network and the COE's Emerald Network. Malta, as a Member State of the European Union (EU), is obliged to protect habitats and species of importance under the EU Habitats Directive and Birds Directive, as well as various multilateral environmental agreements under the *aegis* of the COE or the UN.

As outlined in section 4.4 above, light pollution is detrimental to ecology and wildlife and therefore all efforts should be made to further protect such areas of high importance, in terms of nature conservation, from artificial light.

In this regard, there is the possibility of identifying, promoting and designating parts of the protected terrestrial sites, as shown in Figure 24 (a) as Dark Sky Heritage Areas, while also taking into consideration the coastal areas falling within designated marine protected areas, shown in Figure 24 (b). This may be carried out via specific legislation issued by ERA under the Environment Protection Act (Cap. 549) and/or during the relative Local Plan review exercise by the PA, following further consultations.

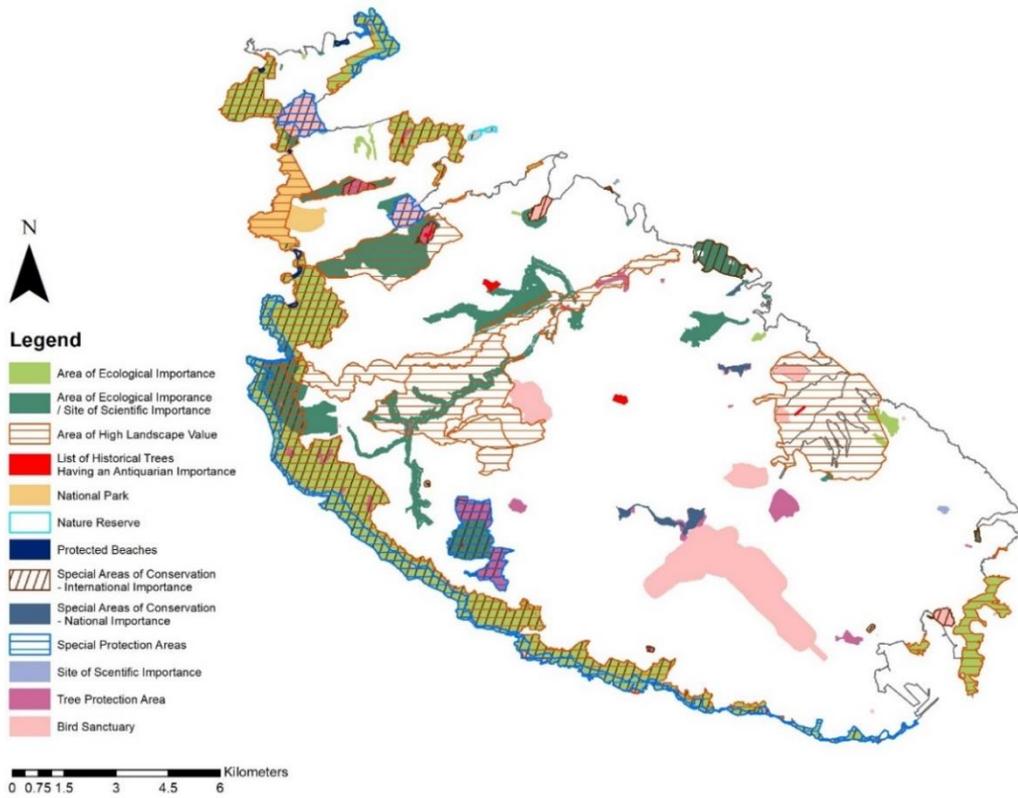


Figure 24 (a): Designated terrestrial protected areas under the Environment Protection Act (Cap. 549) and scheduled areas under the Development Planning Act (Cap. 552) for mainland Malta

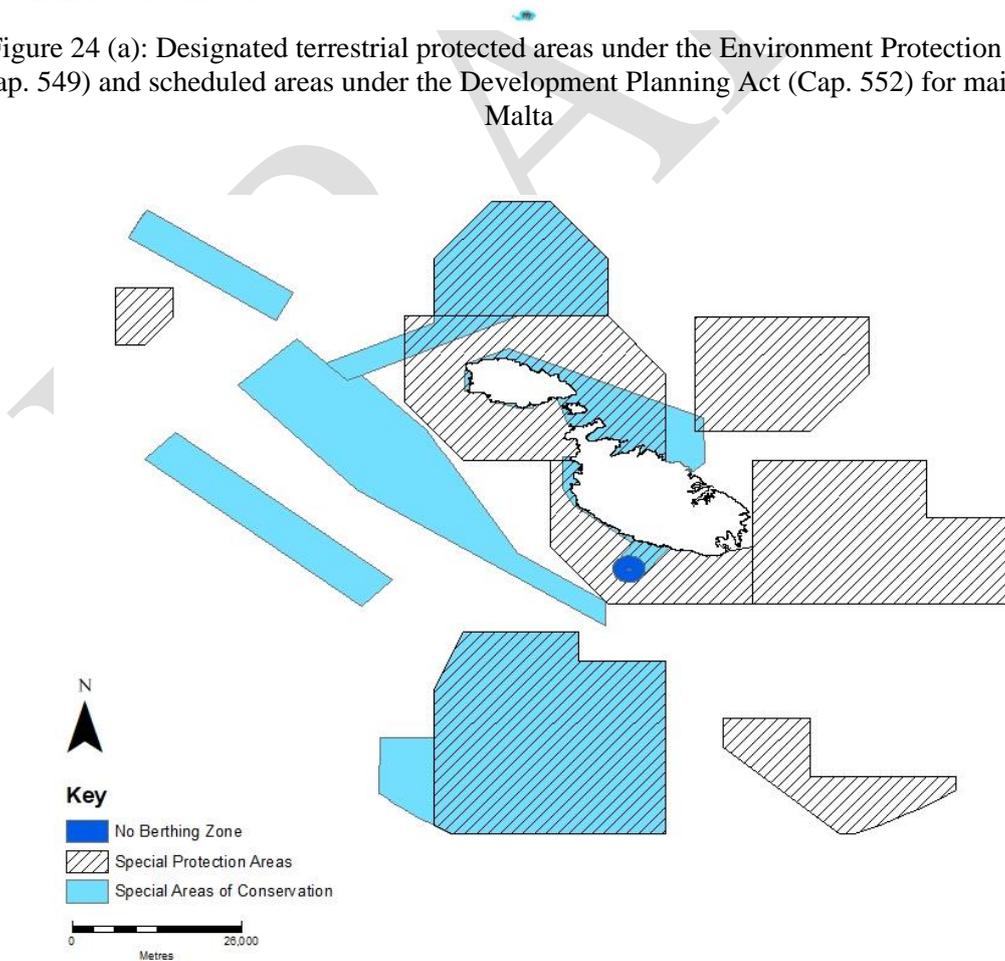


Figure 24 (b): Designated marine protected areas within Maltese waters

8. EXEMPTIONS

Unless within a protected area afforded under the Environment Protection Act (such as SAC's and Natura 2000 sites), temporary lights used for festive decorations may be exempt from these requirements provided such lighting is temporary and is discontinued upon the termination of the celebration/event.

Emergency lighting and lighting required on sites under construction is also exempt, provided such lighting is temporary and is discontinued immediately upon completion of the construction works or abatement of the emergency necessitating the said lighting.

9. DEVELOPMENT APPLICATIONS REQUIREMENTS

Currently, proposals for outdoor artificial lighting located within an UCA, ODZ and close by scheduled property require a clearance from the Planning Authority, while when sited on other locations within the boundaries for development are considered as permitted development.

Applications (both if submitted through DNO procedures and if submitted through a full application) either solely for the installation of artificial lighting or which include such an installation as part of a proposed development, should be accompanied by a lighting scheme report endorsed by an independent warranted engineer demonstrating how and certifying that the proposed lighting will not be a source of light pollution.

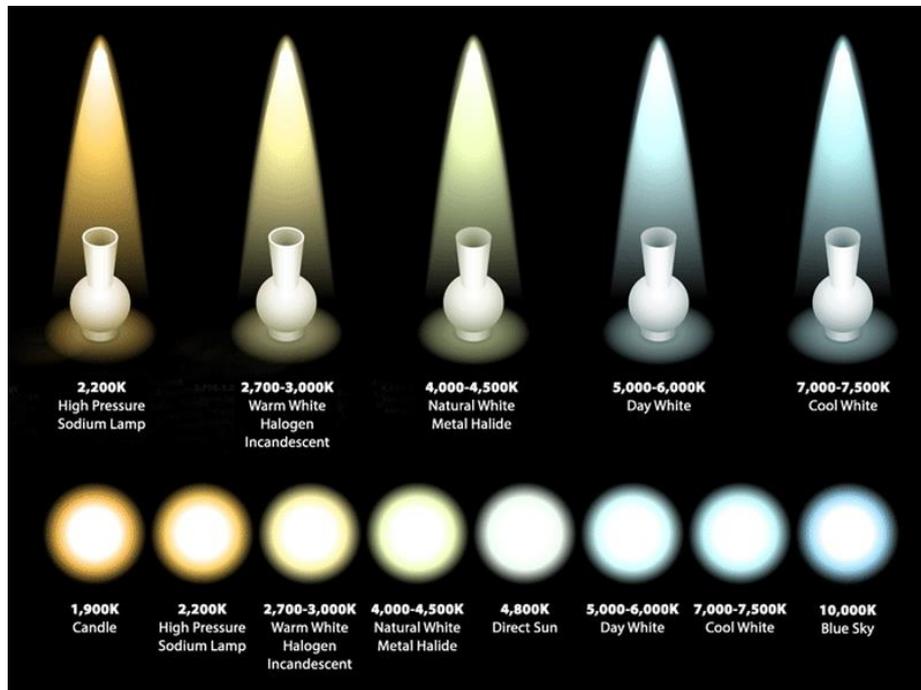
There is no need for such a report in the case of application for terraced residential development since in such cases the permit conditions mentioned in section 6.10 should suffice for the safeguarding against light pollution.

10. GLOSSARY OF TERMS

- **Accent lighting:** Lighting used to emphasise or draw attention to a special object or building.
- **Ambient light:** The general overall level of lighting in an area.
- **Baffle:** An opaque or translucent element to shield a light source from direct view and glare.
- **Brightness:** Strength of the sensation that results from viewing surfaces from which the light comes to the eye.
- **Bulb or lamp:** The source of electric light. To be distinguished from the whole assembly (see luminaire). Lamp often is used to denote the bulb and its housing.
- **Candela (cd):** Unit of luminous intensity. One candela is one lumen per steradian. Formerly called the candle.
- **Candlepower:** Luminous intensity expressed in candelas.
- **Colour rendering:** Effect of a light source on the colour appearance of objects in comparison with their colour appearance under normal day lighting.
- **Cones and rods:** Retinal receptors. Cones dominate the response when the luminance level is high and provide colour perception. Rods dominate at low

luminance levels. No rods are found in the central part of the fovea. Rods have no colour perception ability.

- **Colour temperature:** Also called correlated colour temperature, is a measure of light source's colour appearance compared to a black-body radiator's temperature with similar appearance. Unit is K (Kelvin).



Source: <http://solutions.borderstates.com/color-temperature-and-led-understanding-how-to-choose-led-lamps-for-warm-and-cool-applications>

- **Dark adaptation:** The process by which the eye becomes adapted to a luminance less than about 0.03 candela per square meter (0.01 footlambert).
- **Disability glare:** Glare resulting in reduced visual performance and visibility. It is often accompanied by discomfort.
- **Discomfort glare:** Glare that produces discomfort but does not necessarily diminish visual performance.
- **Efficacy:** The ability of a lighting system to produce the desired result.
- **Efficiency:** A measure of the effective or useful output of a system compared to the input of the system.
- **Fixture:** The assembly that holds the lamp in a lighting system. It includes the elements designed to give light output control, such as a reflector (mirror) or refractor (lens), the ballast, housing, and the attachment parts.
- **Floodlight:** A fixture designed to "flood" an area with light.
- **Flux (radiant flux):** Unit is erg/sec or watts.
- **Full cut-off fixture:** A fixture that allows no emission above a horizontal plane through the fixture when properly installed i.e. has an upward light output of zero.
- **Glare:** Intense and blinding light. Never helps visibility.

- **HID lamp:** Is a discharge lamp, the emitted energy (light) is produced by the passage of an electric current through a gas. High-intensity discharge (HID) include mercury, metal halide, and high-pressure sodium lamps. Other discharge lamps are LPS and fluorescent. Some such lamps have internal coatings to convert some of the ultraviolet energy emitted by the gas discharge into visual output.
- **High-Pressure Sodium (HPS) lamp:** HID lamp where radiation is produced from sodium vapour at a relatively high partial pressure.
- **Illuminance:** Density of luminous flux incident on a surface. Unit is lux.
- **LED:** A light-emitting diode is a semiconductor diode that emits light when conducting current.
- **Light pollution:** The sum of all adverse impacts of artificial light, introduced directly or indirectly into the environment.
- **Light trespass:** Light falling where it is not wanted or needed. Also referred to as spill light or obtrusive light.
- **Low-Pressure Sodium (LPS) lamp:** A discharge lamp where the light is produced by radiation from sodium vapour at low pressure. It is monochromatic light.
- **Lumen:** Unit of luminous flux; the flux emitted within a unit solid angle by a point source with a uniform luminous intensity of one candela. One footcandle is one lumen per square foot. One lux is one lumen per square meter.
- **Lumen per watt (lpw):** A measure of the efficacy of a light source in terms of the light produced for the power consumed.
- **Lumen depreciation factor:** Light loss of a luminaire with time due to the lamp decreasing in efficiency, dirt accumulation, and any other factors that lower the effective output with time.
- **Luminaire:** The complete lighting unit, including the lamp, the fixture, and other parts.
- **Luminance:** At a point and in a given direction, the luminous intensity in the given direction produced by an element of the surface surrounding the point divided by the area of the projection of the element on a plane perpendicular to the given direction. Units: candelas per unit area.
- **Lux:** One lumen per square meter. Unit of illuminance.
- **Mercury lamp:** An HID lamp where the light is produced by radiation from mercury vapour.
- **Metal-halide lamp:** An HID lamp where the light is produced by radiation from metal-halide vapours.
- **Obtrusive light:** The part of the light from a lighting installation that does not serve the purpose for which the installation was designed. It includes: light improperly falling outside the area to be lit, diffused light in the neighbourhood of the lighting installation, sky glow, which is the brightening of the night sky that results from the direct and indirect reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gas molecules, aerosols and particulate matter) in the direction of observation.
- **Polar emission diagram:** A plot of the variation in luminous intensity of a lamp or luminaire.
- **Reflector:** Controlling light output by means of reflection (mirror).
- **Refractor:** Controlling light output by means of refraction (lens).
- **Spotlight:** A fixture designed to light only a small, well-defined area.

- **Stray light:** Emitted light that falls away from the area where it is needed or wanted. Light trespassing on areas not intended to be lit.
- **Task lighting:** Lighting designed for a specific purpose or task.
- **Veiling luminance:** A luminance produced by bright sources in the field-of-view superimposed on the image in the eye reducing contrast and hence visibility.

DRAFT

