Light pollution reduction measures in Europe

EU2022.CZ

Working paper for the international workshop
Light Pollution 2022, during the Czech Presidency
of the Council of the European Union

Prepared by the Ministry of the Environment of the Czech Republic.

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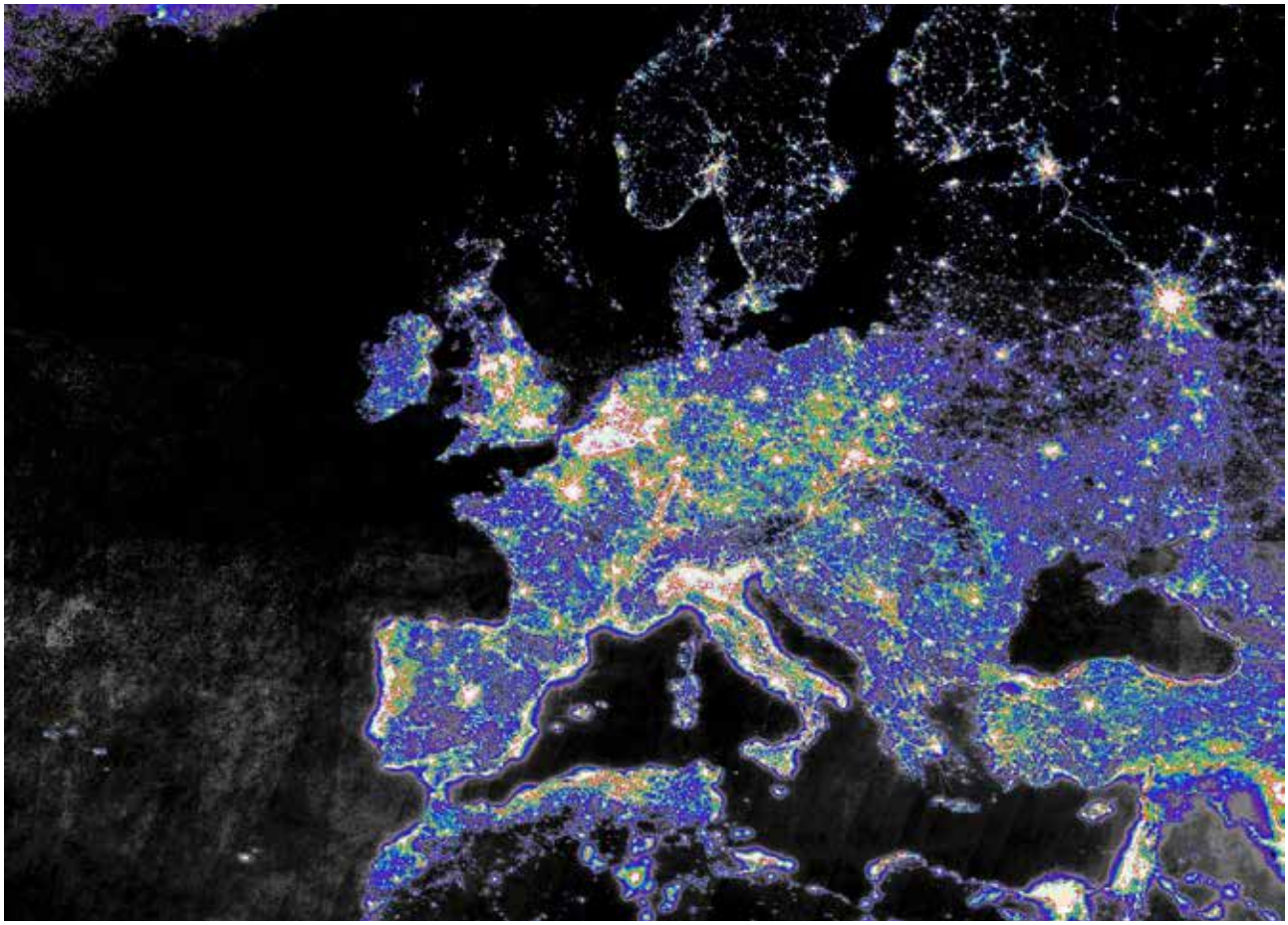
Introduction

Light pollution, an ever-increasing problem of the modern world, can be defined as a set of adverse effects of artificial lighting observed in several areas: human health, nature, economy, road safety and visibility of the starry night sky. ALAN increases globally at unprecedented rates of 2% per year[1]. It was quantified that over 80% of the world and more than 99% of the Europeans live under an illuminated sky at night[2].

Fig. 1: Europe‘s sky brightness



Source: Sanchez de Miguel, A., Kyba, C., Zamorano, J., Gallego, J., & Gaston, K. J. (2020). The nature of the diffuse light near cities is detected in nighttime satellite imagery. Scientific reports, 10(1), 1-16.

Light is an important factor for evolutionary processes for humans, animals and plants. The availability of relatively cheap electricity sources – at least until recently – and especially the development of LEDs (Light emitting diodes) have allowed the introduction of light almost everywhere. On the other hand, real darkness is becoming an increasingly scarce resource. Artificial light produced by LEDs is comparable in spectral composition to daylight due to the presence of wavelengths of the blue and green spectra. Such light sources falsely signal to living organisms that it is daytime, thus disturbing their circadian

1 (Kyba et al., 2017)
2 (Falchi et al., 2016)

rhythm (natural biorhythm synchronising various important processes in the body). In other words, the abundant light sources de-synchronise the human central biological clock, which controls the level of several hormones in the blood (inter alia, melatonin, a strong antioxidant with a direct effect on the immune system), and cause many other problems such as sleep disorders, headaches, work fatigue, stress, obesity and possibly some types of cancer.

Not only humans are however affected in this way. Light pollution poses a serious threat to nocturnal wildlife, having negative impacts on plant and animal physiology. It can confuse migrating animals, alter competitive interactions of animals, change predator-prey relations, and cause physiological harm. Disruption of the patterns of light and darkness has an impact on ecological dynamics and threatens entire ecosystems.

Light also serves as an important indicator for many processes undergone by plants. For example, exposure to artificial light can be confusing for trees, seemingly extending the length of the day, simulating what naturally occurs during vegetation period. This can change flowering patterns and promote continued growth, preventing trees from developing dormancy that allows them to survive winter.

Last but not least, sky glow disturbs not only astronomical observations, but also prevents human contact with the starry sky. Approximately one third of the world's population live in an area where the Milky Way is no longer visible at night due to artificial light[3]. The night sky and stars were recognised by UNESCO as a world heritage to be protected already in 1992.

The economic side of the issue is also worth considering. It is estimated that 15% of all electricity consumption worldwide is spent on lighting[4]. In this sense, light pollution, caused by over-illumination or unnecessary lighting at night, can be considered a pure waste of energy and thus a waste of money, carbon emissions and raw materials.

In some countries, concerns regarding adverse effects of artificial light at night have already triggered action – from legislative regulation on a national, regional or local scale, through the formulation of technical standards for correct lighting parameters, to guidebooks to educate the general public. Backed up by researchers and reports on risk of artificial light at night governments and citizens are beginning to realise that the effects of light pollution are widespread and the intervention is desirable.

Aware that due to its nature, light pollution emitted by a local source can have severe impacts on a regional, national and international scale, light pollution needs to be addressed not only at local or national level, but also international level.

3 https://www.aaas.org/news/one-third-people-cannot-see-milky-way
4 https://www.energy.gov/articles/rise-and-shine-lighting-world-10-billion-led-bulbs

Rationale & Methodology

Aware of the prevalent concern of light pollution, the topic figures on the Agenda of CZ PRES 2022. The Presidency's ambition is to map the approaches of individual European countries to preventing light pollution and to initiate a discussion leading to further European action and setting policies and standards for artificial light at night that would reduce light pollution, keep it at a level that does not harm biodiversity, but at the same time ensure sufficient road and public safety.

To this end, this document shall give an overview of the state of knowledge in various European countries, as well as the measures taken against it. It shall serve as a source of inspiration for countries of what measures has been adopted elsewhere, and shall be a basis for further communication for interested stakeholders during the Light Pollution 2022 Workshop which will take place on October 26th, 2022 in Brno, Czech Republic.

This document is structured into one initial chapter with information on the initiatives of the European Union towards light pollution and 32 country-specific chapters. The purpose of each chapter is to give an overview of the situation in the country, both within the European Union, in the United Kingdom and in the EFTA states (Iceland, Liechtenstein, Norway and Switzerland). The chapters thus contain information on:

- legislation adopted or planned, dealing with light pollution; in some countries, there are designated acts on national (France, Croatia) or regional (Spain) levels for the protection against light pollution. In other countries (Slovenia), decrees are issued for the purpose;
- existing (Austria) or planned (Czech Republic) technical standards guiding the choice of lights with parameters for reduction of spill light, the choice of correct Correlated Colour Temperature (CCT) or others; in general, these are non-binding documents, referred to in a legal document, which makes the standard obligatory;
- manuals or guidelines, which are usually non-binding documents issued by an authority for aiding in the choice of correct lighting equipment and its correct setup, such as in Sweden or Switzerland;
- other documents, initiatives, websites or dark-sky areas existing in the country; these areas do not refer to designated areas according to the International Dark Sky Places Program (IDSP) by the International Dark-Sky Association[5] as in many countries, dark-sky areas are formed independently as a voluntary initiative on a regional or local scale.

The text in each chapter is accompanied by a picture of the country viewed from space during night time and a picture of sky brightness to illustrate the extent of light pollution. The source of all pictures is: *Sanchez de Miguel, A., Kyba, C., Zamorano, J., Gallego, J., & Gaston, K. J. (2020). The nature of the diffuse light near cities is detected in nighttime satellite imagery. Scientific reports, 10(1), 1-16.*

5 https://www.darksky.org/our-work/conservation/idsp/

The case studies from the city of Prague and the city of Brno, the two biggest cities of the Czech Republic, are included to illustrate the city's own initiatives in fighting light pollution.

The document was composed based on desktop research by a team at the Ministry of the Environment of the Czech Republic and underwent a consultation procedure with all the aforementioned countries to correct the information assembled.

European Union

Based on the mapping exercise amongst European countries, most of the countries already take measure to address the light pollution at the national level. These measures comprise mainly legislation, strategies, technical standards, voluntary measures targeting awareness raising manuals or guidelines, research projects or dark-sky areas.

Also, light pollution begins to be addressed at the European level, not only from the perspective of energy efficiency but also from the angle of negative impact on human health and biodiversity.

A voluntary Green Public Procurement Criteria for Street Lighting and Traffic Signals[6], issued in 2018 and updated in 2019, provides guidelines for public decision-makers and lighting professionals for the procurement of lighting equipment based on technical criteria pertaining to the design, installation and operation phase. Light pollution is named as one of the three key environmental impacts of street lighting and traffic signals, together with energy consumption and durability. Criteria that are proposed to decrease the energy consumption (such as dimming during low road use and selecting the lowest necessary road light class to prevent unnecessary over-lighting) also help to reduce light pollution, together with criteria of controlling the upward and horizontal light output ratios, CCT and blue light output. The document introduces a requirement of setting the lighting at ALARA (as low as reasonably achievable) levels, which are however in line with the standard class EN 13201 (Standards for Road lighting) and therefore do not compromise road safety.

In the Zero Pollution Action Plan, a key deliverable of the European Green Deal[7] adopted by the European Commission in 2021, light pollution is named as a pollutant of emerging concern and its research shall be supported through Horizon Europe. Pollutants of emerging concern, including light pollution, shall be included in the Zero Pollution Monitoring and Outlook Framework and thus translated into policy recommendations.

6 Donatello, S., Rodriguez Quintero, R., De Oliveira Gama Caldas, M., Wolf, O., Van Tichelen, P., Van Hoof, V. and Geerken, T., Revision of the EU Green Public Procurement Criteria for Road Lighting and traffic signals, EUR 29631 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-79-99077-9, doi:10.2760/372897, JRC115406.

7 COM/2019/640 final , COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS The European Green Deal

Light pollution was listed as one of the drivers of pollinator decline to be included in the revised EU Pollinators Initiative[8]. This Initiative, adopted by the Commission in 2018, was the first framework addressing the decline of wild pollinators in the EU. Its aims were to spread knowledge about the issue, identify the main causes of the pollinators' decline and engage a wide range of stakeholders and general public in tackling them until 2030. Actions and sub-actions of this Initiative were set until 2020, supporting a more focused use of already existing tools and policies (Birds and Habitats Directive and other environmental policies, the common agricultural policy, cohesion policy and research and innovation policy) towards the objectives of pollinators conservation. Three years later a progress report on the EU Pollinators Initiative concluded that efforts needed to be strengthened in order to overcome the pressing challenges and achieve the objectives. To this aim, the Commission launched a consultation process to gather opinions and input from the general public as well as the scientific community on the hitherto implementation and their suggestions on further actions needed to meet the objectives until 2030. The consultation process offered light pollution among the main drivers of pollinator decline to be added to the revised Initiative.

8 COM/2018/395 final, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS EU Pollinators Initiative

Overview

Country	Legislation[1]	Standard	Manual[2]	Other[3]
Austria	X	✓	✓	✓
Belgium	X	✓	✓	✓
Bulgaria	X	✓	X	X
Croatia	✓	X	X	✓
Cyprus	X	X	X	✓
Czech Republic	(✓)	(✓)	✓	✓
Denmark	(✓)	X	✓	✓
Estonia	X	X	X	✓
Finland	(✓)	X	(✓)	X
France	✓	X	X	✓
Germany	✓	X	✓	✓
Greece	✓	X	X	✓
Hungary	(✓)	X	✓	✓
Iceland	X	X	X	✓
Ireland	X	X	✓	✓
Italy	✓	✓	X	X
Latvia	(✓)	X	X	✓
Liechtenstein	X	X	X	✓
Lithuania	X	X	X	X
Luxembourg	X	X	✓	✓
Malta	✓	✓	(✓)	✓
Netherlands	(✓)	X	✓	✓
Norway	X	X	✓	X
Poland	X	X	X	✓
Portugal	X	X	✓	✓
Romania	X	X	X	✓
Slovakia	(✓)	X	X	✓
Slovenia	(✓)	X	✓	✓
Spain	✓	X	✓	✓
Sweden	✓	(✓)	✓	X
Switzerland	(✓)	✓	✓	✓
United Kingdom	✓	X	✓	✓

1 ✓ means that there is a designated legislative act (on local/ regional/ national level) addressing light pollution; (✓) means that there is no designated legislative act addressing light pollution, but provisions from other legislative acts can be used; X means that there is no legislation addressing light pollution

2 ✓ means that a guidebook/ manual for correct lighting has been issued in the country; (✓) means that a guidebook/ manual is underway; X means that no manual/ guidebook is existing or in preparation

3 Other means the Country has e.g. Dark Sky Area, specific projects, dedicated website.

Austria

Legislation	
Law	X
Decree	X
Standard	ÖNORM O 1052 “Light immissions - measurement and assessment” (2012) - in update 2022
Publication	
Manual	Austrian outdoor lighting guide (2018) [1] Measures of the City of Vienna (2013) [2]
Position papers of the Tyrolean Environmental Ombudsoffice	Artificial lighting at night (2021) [3,4]
Other	
Dark-Sky Area	Nature park Attersee-Traunsee[5]
Project	Long term projects: Helle Not[6] Paten der Nacht[7] Current limited duration projects: SKYSCAPE[8] Lebensraum Naturnacht[9] Sky brightness measuring network of Upper Austria[10] Scientific working group[11]
Website	https://www.bmnt.gv.at/en.html https://wua-wien.at/naturschutz-und-stadtoekologie/lichtverschmutzung https://www.umweltberatung.at/lichtverschmutzung-betriebe

1 https://www.tirol.gv.at/fileadmin/themen/umwelt/naturschutz/downloads/11012018_Leitfaden_Aussenbeleuchtung_Web_KOMPLETT.pdf
2 https://www.stadtrechnungshof.wien.at/berichte/2012/lang/05-01-KA-V-22-1-13.pdf
3 https://www.tiroler-umweltanwaltschaft.gv.at/naturschutz/positionen/single/positionspapier-reihe-kunstlicht-in-der-nacht
4 https://hellenot.org/fileadmin/user_upload/PDF/WeiterInfos/21_PP1_Artificial-light-at-night_EN.pdf
5 https://sternenpark.at/
6 https://hellenot.org/en/home/
7 http://paten-der-nacht.at
8 https://www.tiroler-umweltanwaltschaft.gv.at/naturschutz/naturprojekte/skyscape/
9 https://www.umweltdachverband.at/themen/naturschutz/biodiversitaet/lebensraum-naturnacht/
10 https://www.land-oberoesterreich.gv.at/159659.htm
11 https://astro.univie.ac.at/en/science-communication/reading-material/light-pollution/

Light pollution is not explicitly addressed by Austrian legislation. In nature conservation there is an increasing awareness of negative effects of light pollution on ecological habitats and species. Some ecological aspects of light pollution may be concerned when general environmental laws are made use of (legislation concerning nature protection and environment lies mostly within its nine provincial governments' own responsibilities). Every province in Austria has an Environmental Ombudsoffice. The institutions can influence approved lighting and projects, but mainly only outside the settlements. A standard ÖNORM O 1052 will be updated in autumn 2022, and there is also a manual for proper lighting. Since 2021, there is one International Dark Sky Place, the Dark Sky Park Sternenpark Attersee-Traunsee in the provincial government of Upper Austria, certified by the International Dark Sky Association.

Fig. 2: Austria's sky brightness

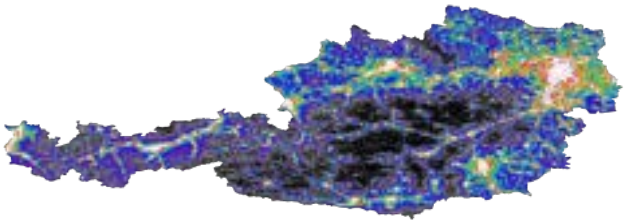


Fig. 3: Austria's night lights

Belgium

Legislation	
Law	X
Decree	In progress: Decree to reduce energy consumption related to non-residential night lighting
Standard	NBN L 18-004 & EN 13201
Publication	
Manual	Kwaliteitsvolle OPENBARE VERLICHTING in West-Vlaanderen (2012)[12] Lichtvisie gewestwegen in Vlaanderen: Belangrijkste wijzigingen (2018)[13]
Other	
Dark-Sky Area	X
Website	http://www.ascen.be/

12 https://www.vlm.be/nl/SiteCollectionDocuments/Nieuwsberichten/folder%20lichtvisie_20110322.pdf
13 https://www.west-vlaanderen.be/sites/default/files/2018-03/LichtvisiegewestwegenErikDeBisschop.pdf

Light pollution maps indicate that Belgium is one of the most illuminated countries. Excess light is mainly due to public lighting (more than 600,000 light points in Wallonia in 2019) and road lighting. In Flanders and Wallonia all public lighting shall switch to LED before 2030.

Some efforts have already been made on the road network: 40% of motorways have dynamic lighting, which allows to regulate lighting in relation to traffic intensity, 35% of streetlights are completely off and 25% are permanently on. Moreover, the old sodium lamps have been replaced by LED with smart features that can further limit excess lighting.[14]

Flanders has legislation concerning light pollution from private light sources (both requiring an environmental permit and otherwise) since 1996, where it figures as light nuisance. It is part of the VLAREM II or the Flemish Regulation for Environment. However, public lighting is not covered by those regulations. The municipalities of West-Flanders province have light pollution in focus through information and experience sharing on many aspects of public lighting including reducing light pollution, resulting into action in removing lighting installations, choosing alternative options or adaptive lighting. Some municipalities are also part of Interreg projects, such as SLIC on Smart Light Concepts[15], TVBuONAIR[16] and SMARTLIGHTHUB[17].

LED billboards located in close vicinity of the roads are regulated by the Flemish government mainly with a focus on traffic safety. The regulations contribute also to the reduction of light pollution. In addition, research on unnecessary lighting will be launched with the aim of eliminating light pollution and reducing the electricity consumption of municipalities and protecting biodiversity.[18] In November 2021 a Resolution setting out the steps was adopted.[19] Currently both the Walloon Agency for Nature and Forests and the Flemish Institute for Nature and Forest Research (INBO) have substantial research activities on the impacts of light pollution and includes these issues in statements relating to the development of natural areas.

Finally, since 1995, the Association for the Protection of the Sky and the Nocturnal Environment has organized an annual “Night of Darkness” to raise citizens´ awareness about the issue of light pollution.

Fig. 4: Belgium‘s sky brightness

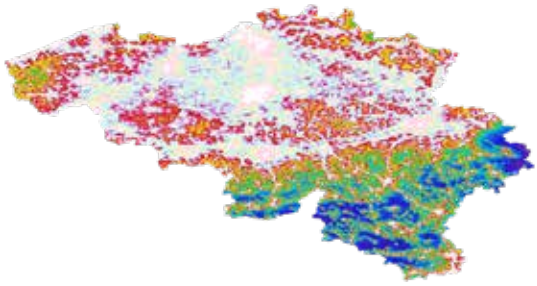


Fig. 5: Belgium‘s night lights

14 https://wegenenverkeer.be/wegen/openbare-verlichting
15 https://www.interreg2seas.eu/en/slic
16 https://www.tvbuonair.eu/
17 http://smartlighthub.eu/
18 https://www.rtc.be/la_pollution_lumineuse_sur_la_table_du_parlement_wallon-1510727-999-325.html
19 https://www.parlement-wallonie.be/pwpages?p=doc-recherche-det&iddoc=103170

Bulgaria

Legislation	
Law	X
Decree	X
Standard	National standard BDS EN13201-2:2016
Publication	
Manual	X
Other	
Dark-Sky Area	X
Website	X

Light pollution is neither under the purposeful and explicit supervision of environmental authorities, nor included in the general legislation. The Bulgarian Environmental Protection Law regulates the public relations related to the implementation of control over the state of environment and the sources of pollution. The objectives of the law are achieved through control over the condition and use of the components of the environment and the sources of its pollution and damage. Light pollution is not introduced as terminology explicitly, but it could be considered in environmental impact assessments, environmental assessment or compatibility assessment (e.g. for sensitive species). On a regional level, several municipalities issue ordinances on advertising, informational and monumental decorative elements, which could impose reasonable regulation of light exposure, considering the effect on human health. A voluntary Bulgarian national standard BDS EN13201-2:2016 includes requirements for limiting light pollution by minimizing light intrusion in spaces where it is neither necessary nor desirable, such as into private property or over the horizon and scattered in the atmosphere.

Fig. 6: Bulgaria‘s sky brightness

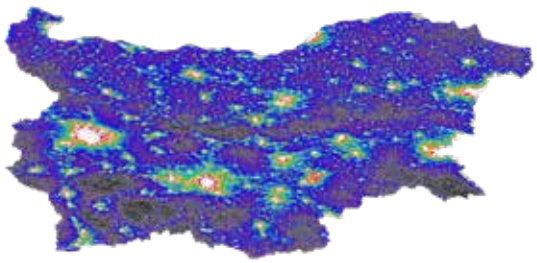
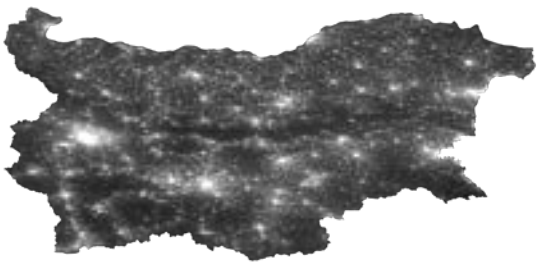


Fig. 7: Bulgaria ‘s night lights



Croatia

Legislation	
Law	NN 14/2019 Act on Protection against Light Pollution (2019)[20]
Decree	NN 128/2020 Ordinance on lighting zones, permitted lighting values and methods of managing lighting systems (2020)[21] In progress: Ordinance on the content, format and drafting the lighting plan and action plan for the construction and/or reconstruction of outdoor lighting (Article 12, paragraph 9 and Article 13, paragraph 5 of the Act) In progress: Ordinance on the measurement and monitoring of environmental lighting (Article 10, paragraph 3 of the Act).
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	Petrova gora[22], Vrani Kamen [23]
Website	https://mingor.gov.hr/o-ministarstvu-1065/djelokrug/uprava-za-klimatske-aktivnosti-1879/svjetlosno-oneciscenje/1324 http://www.astronomskisavez.hr/ https://www.hdr.hr/

Measures to protect against light pollution include protection against unnecessary and harmful light emissions into space, in the zone and outside the zone to be illuminated, and measures to protect the night sky and natural water bodies and protected areas from artificial lighting, considering health, biological, economic, cultural, legal, security, astronomical and other conditions and needs.

The Light Protection Act (No. 14/19) regulates the principles and entities implementing protection, setting lighting management standards in order to reduce energy consumption, measures to protect against excessive lighting, restrictions and prohibitions related to light pollution, planning of construction, maintenance and reconstruction of lighting, and the responsibility of manufacturers for lighting products

The Ordinance on lighting zones, permitted lighting values and methods of managing lighting systems (No. 128/20) based on Article 9 of the Light Pollution Protection Act (No. 14/19) prescribes mandatory lighting control methods and conditions, lighting zones, protection measures, maximum permissible lighting values, conditions for selection and installation of lamps, energy efficiency criteria, maximum permissible values of CCT and use of environmentally friendly lamps.

20 https://narodne-novine.nn.hr/clanci/sluzbeni/2019_02_14_271.html
21 https://narodne-novine.nn.hr/clanci/sluzbeni/2020_11_128_2442.html
22 https://daruvar.hr/ptn_vrani-kamen/
23 http://www.ad-beskraj.hr/petrova-gora-prvi-hrvatski-park-tamnog-neba

The Ministry of the Economy and Sustainable Development, as the expert body along with a working group, is preparing:

- Ordinance on the content, format and drafting the lighting plan and action plan for the construction and/or reconstruction of outdoor lighting (Article 12, paragraph 9 and Article 13, paragraph 5 of the Act),
- Ordinance on the measurement and monitoring of environmental lighting (Article 10, paragraph 3 of the Act).

Fig. 8: Croatia's sky brightness

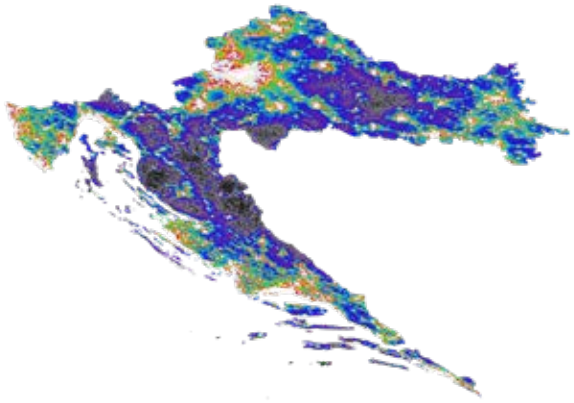
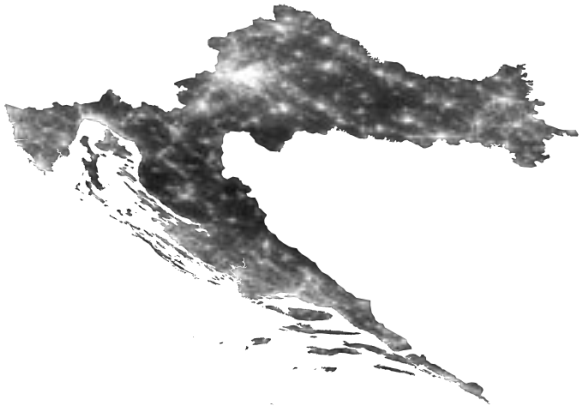


Fig. 9: Croatia's night lights



Cyprus

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	X
Website	https://www.facebook.com/darkskycy/ http://www.cyprusastronomy.org/

In Cyprus, light pollution is not on the agenda of any public authority. The Department of Environment under the Ministry of Agriculture is responsible for conducting environmental impact assessments of new development that could have an impact on turtle nesting sites or bird foraging sites that are not part of the Natura 2000 network. The permit for these developments includes conditions of light wavelength, the height of the light source and visibility from the beach.

Fig. 10: Cyprus‘s sky brightness

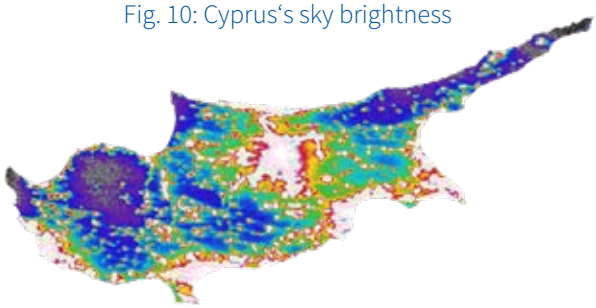
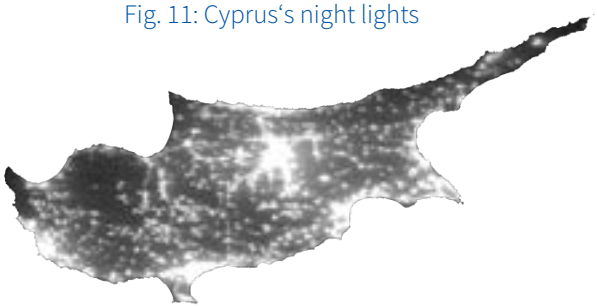


Fig. 11: Cyprus‘s night lights



Czech Republic

Legislation	
Law	Act of the Czech National Council on Nature and Landscape Protection (1992) – light pollution in the territory of national parks (2017)[24] Methodological guidelines to the EIA Act (2001) for the prevention and reduction of light pollution (2020)[25]
Standard	ČSN 36 0459 (Reducing the undesirable side effects of outdoor lighting - in preparation); ČSN EN 12464-2; ČSN EN 12193; ČSN EN 13201-2
Publication	
Manual	Simple Lighting Manual (Ministry of the Environment, 2017, updated 2021)[26]
Other	
Dark-Sky Area	Bystřická, Manětínská, Jizerská, Beskydská Dark Sky Areas
Strategy	State Environmental Policy 2030 (2021)[27]
Website	https://www.facebook.com/Svetelne.znecisteni, https://svetelneznecisteni.cz/

In 2002, light pollution was introduced into Act No. 86/2002 on air protection, by which the Czech Republic became a frontrunner in the fight against light pollution; however, no implementing decree was issued and light pollution was omitted as part of the amendments to the Act.

In 2017, an inter-ministerial working group was set up, coordinated by the Ministry of the Environment. This group prepared an informative material for the Government of the Czech Republic on the effects of light pollution and the absence of a solution to this problem, followed by a document with the basic points of the solution. Following this, Act No. 114/1992 on Nature

24 https://www.mzp.cz/www/platnalegislativa.nsf/58170589E7DC0591C125654B004E91C1/%24file/z114_1992.pdf
25 https://portal.cenia.cz/eiasea/dokumenty/dokumentSoubor/167/SZ_EIA%20Metodika_final.pdf?lang=cs
26 https://www.mzp.cz/C1257458002F0DC7/cz/news_20210511-MZP-vydava-osvetlovaci-prirucku-pro-obce-projektanty-i-obcany/$FILE/Osv%C4%9Btlovac%C3%AD%20p%C5%99%C3%ADru%C4%8Dka%20-%20tisk.pdf
27 https://www.mzp.cz/C1257458002F0DC7/cz/statni_politika_zivotniho_prostredi/$FILE/SPZP-2030_4AK_EN-20220525.pdf

and Landscape Protection was updated in 2017, setting out the conditions for introducing light sources into national parks in order to prevent light pollution. In the meantime, the first Simple Lighting Manual, which was updated in 2021, was also published[28]. The Manual provides recommendation for public lighting as well as for private entities or architecture lighting.

Since 2017, rules for reducing light pollution have been included in state financial support for the modernization of lighting systems. Only lights 2700 K and lower are currently eligible for the subsidy. In 2022, a new standard on Limiting the Undesirable Effects of Outdoor Lighting is in preparation. An Implementing Decree to the new Building Act is also being developed, which should specify technical parameters of lighting installations.

As a sign of public interest, public hearing was held in 2020 in the Senate on "Light - a good servant, a bad master". In addition to various conferences and seminars, since 2020, the Ministry of the Environment has been organizing a Light Pollution conference every year. The conference in 2022 will be part of the Czech Presidency to the EU (July - December 2022).

Based on memoranda, 4 areas of dark sky (Bystřická, Manětínská, Jizerská and Beskydská) have been declared on the territory of the Czech Republic which help to raise awareness.

Fig. 12: Czech Republic's sky brightness

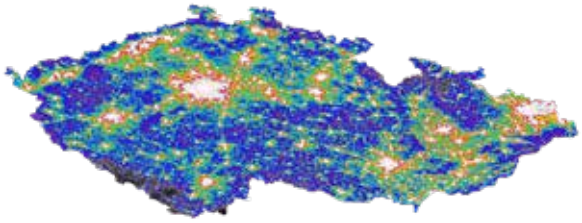


Fig. 13: Czech Republic's night lights

28 http://extwprlegs1.fao.org/docs/pdf/den100356.pdf

Denmark

Legislation	
Law	Nature Protection Act (2009)[29] protecting the open landscape against, among others, light advertising installations Building Act (2010)[30] giving the municipal councils the right to control that lighting installations do no harm to their surrounding environment Building Conservation Act (2011)[31] prescribing the obligation to get a permission from the Ministry of Culture to install light on a protected building
Decree	817/2018 (§ 2 par. 1 – advertising in open landscape - no light, retroreflective or moving; including digital screens)
Notice	Notice on Building site lighting in winter (2020) sets rules for installing lighting of building sites such that the lights shall be of no discomfort to anyone passing or living nearby
Publication	
Manual	Road lighting (Road Directorate, 2020)[32] + English version 2015
Other	
Dark-Sky Area	Dark Sky Park and Community in Møns Klint
Website	www.lysforurening.dk

Light pollution is regulated by a range of sector specific acts addressing the scope of the activity. It is reflected in the EIA Act when it comes to landscape effects or general disturbance. The Act however does not deal with light spectral characteristics, intensity or timing. General recommendations for projects include not to over-light, use blinking rather than constant light, shield all lights towards the sky and switch them off whenever not necessary.

A Road lighting handbook[33] was issued by the Danish Road Directorate, containing best-practice recommendations for public lighting installations in streets and roads. It states that spill light into the night environment should be limited as much as possible. In areas with cyclists and pedestrians, it is recommended to use lights of 3000 K, in other roads 4000 K are recommended. The handbook also recommends minimizing the impact on flora and fauna by limiting the blue, violet or UV light and in some especially sensitive areas, red and infrared light - in practice using light sources of max. 2000 K. Lighting the night sky should be avoided by limited use of lighting in the open landscape, choice of appropriately low lighting classes, use of luminaires with a high shielding class, and dimming of light during low traffic.

29 http://extwprlegs1.fao.org/docs/pdf/den100356.pdf
30 http://extwprlegs1.fao.org/docs/pdf/den99311.pdf
31 https://www.informea.org/en/legislation/act-promotion-energy-conservation-buildings-no-646-2011
32 https://en.vejregler.dk/h/7e0fba84-06dd-483b-898a-c7b3e3affaa1/64c7b17b30634c6889ba17d3346f28ed?showExact=true
33 https://vejregler.dk/api/Portals(6a8179a8-e164-4fc9-a59b-191699ffa1ee)/Documents/Variant(Pdf)/h/7e0fba84-06dd-483b-898a-c7b3e3affaa1/vd20200109?partName=vd20200109.pdf

The island Samsø participated in the Night Light Interreg EU project bringing together regional authorities in Netherlands, Hungary, Spain, Luxembourg, Denmark, Slovenia and Italy in an endeavour to reduce light pollution and protect night skies by improving local policies.[34]

Fig. 14: Denmark's sky brightness

Fig. 15: Denmark's night lights

Estonia

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	X
Project	Tallinn – Canute Garden, ENLIGHTENme project Institute of Physics in TalTech University: Investigation of long-term changes in light pollution in Tallinn and determination of the current state of light pollution in Estonia Street lighting in seven cities (Environmental Investment Centre)[35]
Strategy	Tallinn 2035[36]
Website	http://www.envir.ee

34 https://www.interregeurope.eu/find-policy-solutions/stories/night-light-the-unexpected-potentials-of-a-dark-night-sky
35 https://kik.ee/en/eic-projects/street-lighting-seven-cities
36 https://www.visittallinn.ee/static/files/087/visittallinn_2035_development_strategy_final.pdf

In Estonia, there is no national policy on light pollution. However, at the city-level steps are already being taken towards adaptive lighting. Tallinn has set priorities in street lighting development, including efforts to minimise light pollution. With the city of Tartu, both are LUCI3[37] (Light Urban Community International) members and take part in various projects concerning lighting.

The City of Tallinn has its own principles for city lighting that prioritize city safety and aesthetic aspect. Street lighting is managed through the GSM network, giving an overview of the street lighting situation in real time for maintenance. Avoiding light pollution is one of the objectives of the city lighting management.

Tallinn's development strategy „Tallinn 2035" admits that „well-thought-out lighting helps to create a safe and pleasant urban space" and „Thanks to the good lighting of the urban space, people feel safer when driving in the dark. There is minimal light pollution." The LUCIA (energy efficient urban lighting experts) pilot project in Tallinn[38] aims to create a park with seasonally changing lights, using modern lighting possibilities. A large project has been carried out by the Institute of Physics in TalTech University with Environmental Investment Centre funding "Investigation of long-term changes in light pollution in Tallinn and determination of the current state of light pollution in Estonia".[39]

In 2020, the preparation of a Public Lighting Master Plan for the city of Tartu was initiated[40], which should be completed in 2022, to make street lighting more economical. However, the health aspect has not been considered. The ENLIGHTENme project will show how outdoor and indoor lighting affects people's health and find links between health, well-being, lighting and socio-economic factors. As part of the project, a local lighting lab as an innovation has been implemented and residents are actively involved in the development of outdoor lighting in their residential area[41].

Fig. 16: Estonia's sky brightness

Fig. 17: Estonia's night lights

37 https://www.luciassociation.org/member-city/
38 https://lucia-project.eu/pilot-sites/tallinn-estonia/
39 https://www.kik.ee/sites/default/files/144.pdf
40 https://www.luciassociation.org/map-city/tartu-2/
41 https://www.enlightenme-project.eu/cities/tartu

Finland

Legislation	
Law	Environmental Protection Act (2014)[42] Land Use and Construction Act (1999)[43] Nature Conservation Act (1996)[44]
Decree	X
Standard	X
Publication	
Manual	Light pollution reduction measures: The city of Helsinki (2021)[45]
Other	
Dark-Sky Area	X
Website	www.syke.fi/jarilyytimaki/en https://helda.helsinki.fi/handle/10138/135831 https://lightingjournal.org/index.php/path/article/view/96

No Finnish legislation specifically addressing light pollution exists. However, several existing pieces of law contain notions of light as a potential disturbance or pollution source. The Environmental Protection Act (527/2014) prohibits or limits any emissions, including light, that may pollute the environment. In the EIA for large projects, their light conditions also need to be considered (e.g. greenhouses or wind turbines) in the permitting procedure. Land Use and Construction Act (132/1999) contains limitations for use of neon signs. Under the Nature Conservation Act (1096/1996) certain light emissions can be treated as a threat to biodiversity, natural values and landscape. In the Neighbourhood Relations Act (26/1920) it is prohibited to impose nuisance on surrounding properties by, among other, light emission. Provisions in the Health Protection Act (763/1994) can also be understood to include light as a source of potential health adverse effects[46].

A guidance document Helsinki Interference Light Report (2014)[47] defines main light pollution sources in the city and recommends technical specifications of lights to avoid light pollution.

42 https://finlex.fi/en/laki/kaannokset/2014/en20140527_20190049.pdf
43 https://www.finlex.fi/fi/laki/kaannokset/1999/en19990132.pdf
44 https://www.finlex.fi/fi/laki/kaannokset/1996/en19961096.pdf
45 https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-07-21.pdf
46 https://helda.helsinki.fi/bitstream/handle/10138/135831/SYKEra_27_2014.pdf?sequence=1&isAllowed=y
47 https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-07-21.pdf

Fig. 18: Finland's sky brightness

Fig. 19: Finland's night lights

France

Legislation	
Law	Law n° 2010-788 12 (2010)[48] national commitment to the environment Law n° 2021-1104 of 22 (2021)[49] for fight against climate change and building resilience to its effects
Decree	Decree concerning the prevention, reduction, and limitation of light pollution and defining the list and the perimeter of exceptional astronomical observation sites in application of Article R. 583-4 of the Environmental Code (2018) [50]
Standard	X
Publication	
Report	À la reconquête de la nuit - La pollution lumineuse: état des lieux et propositions (2018)[51]
Other	
Dark-Sky Area	Alpes Azur Mercantour Reserve, Cévennes National Park, Pic du Midi Reserve, Regional Natural Park of Millevaches (Limousin)
Website	https://www.ecologie.gouv.fr/politiques/pollution-lumineuse

France addresses the light pollution issue, as much in the government as in the academic sphere, the local community or association for the protection of the environment. France has chosen not to create a new standard but to update manuals that specify the measures to be taken (existing standards about public lighting take into account only the security aspect, which often does not provide relevant details for the prevention of light pollution).

48 https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000022470434
49 https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043956924
50 https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037864346
51 https://cgedd.documentation.developpement-durable.gouv.fr/documents/Affaires-0010973/012301-01_rapport-publie.pdf;jsessionid=A9AD991EDA0659024692C4B2B75E00A2

France has had a decree since 2018 aiming to reduce or prevent light pollution, specifying requirements for the design and operation of outdoor lighting installations and regulations for public and private property owners, such as curfews for outdoor lighting, upward light ratio and specification for 11 sites for astronomical observatories throughout France. It also sets global restrictions which are:

- CCT does not exceed 3000 K for all outdoor artificial lights, 2700 K in "building sites" in protected areas and 2400 K otherwise in protected areas
- in any installation, the number of lumen per square meter of illuminated target surface cannot exceed 35 and 10 for suburban and rural settings, respectively;
- excess light trespass into dwellings is prohibited
- the use of skybeams, lasers and similar high-intensity light and night-time lighting of waterways is prohibited.

Supported by the French Ministry of Environment and organized by the National Association for the Protection of the Night Sky and Environment (ANPCEN), the national "Starry Towns and Villages" label recognizes initiatives to improve the quality of the night and the night-time environment.

Annual events are organized such as "Night of Darkness" to raise the awareness of the public about the issue of light pollution or "The Nights of the Stars" that allows to put forward, beyond the classical themes of astronomy, the need to protect the night sky from light pollution.

Fig. 20: France's sky brightness

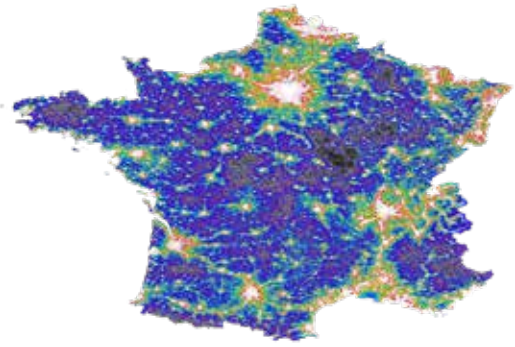


Fig. 21: France's night lights

Germany

Legislation	
Law	Federal Nature Conservation Act (2021)[52]
Decree	In progress (2025): Decree to protect animals and plants from light pollution
Standard	X
Publication	
Manual	Guidance Document about the requirements for sustainable outdoor lighting (2019)[53]
Other	
Dark-Sky Area	The Westhavelland Nature Park
Website	www.cost-lonne.eu

On the national scale, light pollution is the responsibility of the Ministry of the Environment and the Federal Agency for Nature Conservation (Bundesamt für Naturschutz), on regional level in the 16 federal states the state agencies for Nature Conservation and on local level the municipalities.

Moreover, there are regional and local strategies for reducing light pollution, e.g. Sternenpark Rhön[54], Sternenpark Eifel[55], Sternenpark Westhavelland[56], Sternenpark Weinklmoos-Alm[57] Sternenstadt Fulda[58], Sterneninseln Pellworm[59] and Spiekeroog[60].

Light pollution is addressed in the Federal Nature Conservation Act (2021), specifying that new construction of street lighting as well as illuminated advertising installations are prohibited in nature reserves as well as in core and maintenance zones of biosphere reserves, with exceptions possible in individual cases. Furthermore, general regulations are to be applied, according to which any significant adverse effects on nature and landscape shall primarily be avoided. Unavoidable effects are to be offset via compensation or substitution measures or, where this is not possible, via monetary substitution. In addition, species protection law must also be observed in the context of adverse effects of lighting.

Currently, a more far-reaching legal Decree is being prepared, probably for the year 2025, which explicitly addresses the protection of nature from light pollution. The Federal

52 http://extwprlegs1.fao.org/docs/pdf/ger96959.pdf
53 https://www.bfn.de/sites/default/files/2022-05/skript543_4_aufl.pdf
54 https://www.biosphaerenreservat-rhoen.de/natur/sternenpark-rhoen/
55 https://www.nationalpark-eifel.de/de/nationalpark-erleben/sternenpark
56 https://www.sternenpark-westhavelland.de
57 https://www.reitimwinkl.de/sternenpark
58 https://www.sternenstadt-fulda.de
59 https://www.Sterneninsel-Pellworm.de
60 https://www.Sterneninsel-Spiekeroog.de

Nature Conservation Act (2021) already contains a provision that outlines the content of this legal Decree. It will includespecific regulations to protect animals and plants from adverse effects of lighting when installing and operating new lighting, or renewing existing lighting (on roads, paths, outdoor structures, properties and advertising installations). Furthermore, an authority responsible for nature conservation and landscape management will be able to order design or technical protective measures for construction or alteration of a lighting installation. The Decree will be drafted on the basis of 3 new research projects (threshold of vulnerable organisms, development of an application-suitable and cost-effective light measurement method) including technical standards for light at night.

In a publication co-issued by the German Nature Conservation Agency (BFN), there is a thorough description of harmful effects of light installations and technical parameters to minimise light pollution. It recommends using lights of 2400 K in protected nature areas, and no more than 3000 K, or PC Amber. Lights of 3000 K are recommended also for new LED installations in streets, together with a suitable geometry and light intensity.

Fig. 22: Germany‘s sky brightness

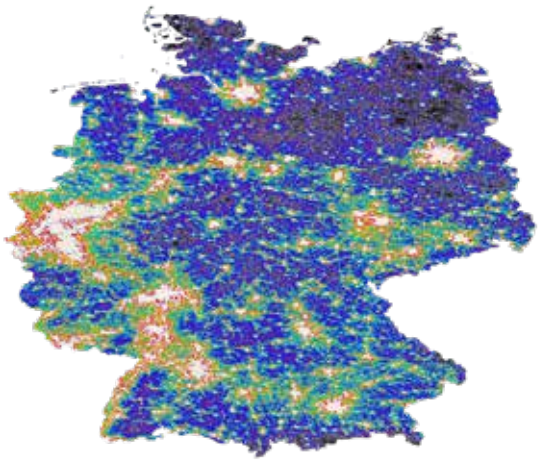


Fig. 23: Germany‘s night lights

Greece

Legislation	
Law	X
Decree	Decree n°68083/2147/2021: National Action Plan for the Protection of Caretta Caretta in Greece Decree n°24/2020: Municipality of Maroussi Approval of Special Spatial Plan in the area of the former Olympic Village Press Decrees n°474/2020 and n°564/2020: Determination of terms, conditions procedure for the concession of simple use of the seashore Decree n°5479/2020: Integrated Civil Intervention Plan for the Municipality of Heraklion, Crete Decree n°56468/2020: Defining terms, conditions, technical issues, necessary details and procedure for the concession of the shoreline, beach, shore and riparian zone, sea, lagoon, large lakes and navigable rivers Decree n°391/2018: Characterization of Kyparissia Bay as Nature Protection Area, definition of protection zones, uses, conditions and building restrictions Decree n°09/2016: Approval of Special Spatial Development Plans for Public Real Estate, with the name “Afandou Rodou” in the beach area of Afandou Decree n°133/2015: Specifications for the Preparation of Parks and Gove Management Studies Decree n°125/2013: Compilation Specifications of the Management Studies of Common Green Areas Decree n°443/2005: Technical Specifications of studies on regulatory plans and programs on environmental protection Decree n°22/1999: Establishment of National Marine Park of Zakynthos
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	Mt. Aenos
Website	X

Greece has legislation concerning light pollution for special cases such as within protected areas. National provisions on lighting are mainly focused on energy savings, rather than light pollution. However, the provisions and measures are taken ad-hoc to mitigating the impact of light pollution on protected species in areas inhabited by species in need of protection and disturbed by light pollution (protected species of the Species and Habitats Guidelines on wild birds), through the PD designation of areas (e.g. Kyparissia Bay, Laganas, Zakynthos) or through other Ministerial decisions for the protection of areas that have not yet been designated. According to the respective legislation, measures should be taken in order to reduce light spillage on beaches with inter alia sea turtle nesting sites by means of replacing problematic light sources, creating buffers, etc.

The recently adopted National Action Plan for the Protection of Caretta caretta in Greece prioritizes the implementation of studies aiming to mitigate the impact of light pollution on some of the principal nesting sites of Greece. A study carried out in the framework of the National Plan for Sea Turtles entitled "Life Euroturtles collective actions for improving the conservation status of the EU sea turtle populations" mentioned the negative effects of light pollution on various animal species due to their misorientation. The same study envisages the preparation of a study to reduce light pollution in various other areas of Greece with similar problems. The proposed measures will be institutionalized in the Management Plans of the specific protected areas. Through the NRPs prepared for all NATURA 2000 protected areas, measures will be provided to address light pollution as a threat to specific species. Additionally, a detailed study was made about a particular area in order to create a Dark Sky Park.

Fig. 24: Greece's sky brightness

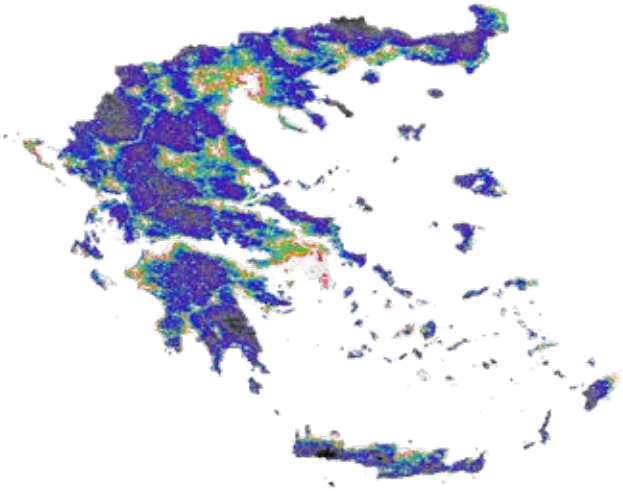


Fig. 25: Greece's night lights

Hungary

Legislation	
Law	Act LIII on Nature Conservation (1996)[61]
Decree	Decree No. 253/1997 (XII. 20.)[62] of the Government on the requirements of town planning and construction Decree No. 45/2020 (IX. 21.)[63] of the minister of agriculture on designation of the buffer zone of the Hortobágy National Park
Standard	X
Publication	
Manual	On light pollution - clearly! (2020)[64]
Other	
Dark-Sky Area	Hortobágy Starry Sky Park, Zselic Starry Sky Park, Bükk Starry Sky Park[65]
Website	https://www.termeszetvedelem.hu/csillagosegbolt-park-cimmel-rendelkezo-teruletek

Hungary does not have comprehensive legislation directly aimed at light pollution, however, the issue is addressed mostly within protected areas and dark sky parks, of which there are several in Hungary. Light pollution measurements took place in Hungarian national parks within the scope of cooperation with a consortium of researchers and, under the EFOP-3.6.2-16-2017-00014 human resources development operative program, the "Development of an International Research Environment in the Field of Examining Light Pollution" project. In addition to the foregoing, some of the activities designed to preserve light-sensitive protected species (e.g. bats and insects) are related to preventing and minimizing light pollution (e.g. controlled decorative lighting of buildings inhabited by bat colonies in the area of the Aggtelek National Park Directorate; cooperation agreements with the operators).

In the Night Light Interreg EU project bringing together regional authorities in Netherlands, Hungary, Spain, Luxembourg, Denmark, Slovenia and Italy in an endeavour to reduce light pollution and protect night skies by improving local policies, the Hortobágy National Park Directorate participated to develop sustainable astrotourism activities.[66]

61 https://www.asser.nl/upload/eel-webroot/www/documents/HUN/hungary%20Nature%20Conservation%20law.htm
62 OTÉK - 253/1997. (XII. 20.) Korm. rendelet az országos településrendezési és építési követelményekről - Hatályos Jogszabályok Gyűjteménye (jogtar.hu)
63 https://net.jogtar.hu/jogszabaly?docid=A2000045.AM&txtreferer=00000001.txt
64 https://termeszetvedelem.hu/_user/browser/File/Fenyszennyezeses%20utmutato/Fenysz_utm_v_publ_2020_10_01.pdf
65 https://www.termeszetvedelem.hu/csillagosegbolt-park-cimmel-rendelkezo-teruletek
66 https://www.interregeurope.eu/find-policy-solutions/stories/night-light-the-unexpected-potentials-of-a-dark-night-sky

Fig. 26: Hungary's sky brightness

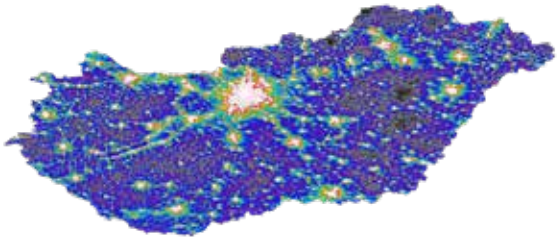


Fig. 27: Hungary's night lights

Iceland

Legislation	
Law	Building Regulation (2012) [67] Spatial Planning Regulation (2013)
Decree	X
Standard	X
Publication	
Manual	Guidelines for outdoor lighting (2021)[68]
Other	
Dark-Sky Area	X
Website	https://www.npr.org/sections/thetwo-way/2016/09/29/495946913/reykjavik-turns-off-street-lights-to-turn-up-the-northern-lights?t=1655189948042

There is no specific legislation for light pollution but there are some provisions found in regulations. The Building Regulation (2012) defines light pollution as the effect on the environment of too much and excessive lighting in the night darkness. There are provisions in the regulation regarding prevention of light pollution and lighting to have a luminaire that is directed downwards, especially in open spaces, on residential sites and outdoor lighting on houses. Iceland Construction Authority has published guidelines for outdoor lighting to prevent light pollution. In the Spatial Planning Regulation (2013) there are provisions about municipalities setting conditions in local plans regarding use of light on residential sites, public spaces and the use of illuminated advertising installations.

Due to the specific geographical area, summer daytime lasts almost 24 hours which means that no public lighting is needed. On the other hand, winter nights are very long and thus the situation is reversed. Nevertheless, wintertime is the best part of the year for observing the northern lights which became an important tourist attraction in Iceland. Since then, several dark sky observatories have been created for better observation. In the same spirit, in 2016, the lights of Reykjavik city turned off for a few hours to allow its citizens to see the northern lights and thus raise awareness about light pollution.

67 https://island.is/reglugerdir/nr/0112-2012
68 https://byggingarreglugerd.kreatives.is/wp-content/uploads/2022/04/1042-krofur-utilysing-17.pdf

Fig. 28: Iceland's sky brightness

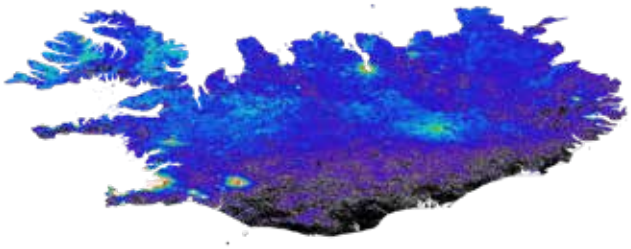
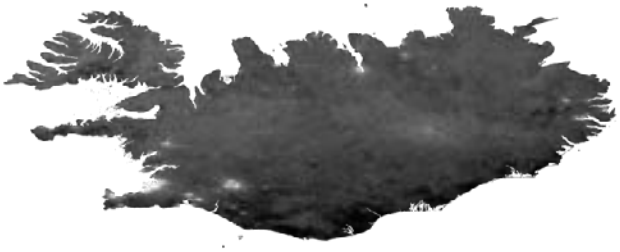


Fig. 29: Iceland's night lights



Ireland

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	It's time to protect the Night (2017)[69]
Other	
Dark-Sky Area	Kerry International Dark Sky Reserve, Mayo International Dark Sky Park
Website	https://www.capjournal.org/issues/28/28_51.pdf

The manual Protecting the night by the Mayo Dark Sky Park gives general information, digital data and facts about light pollution in Ireland, as well as recommendations for local authorities, domestic and commercial lighting. However, the recommendations for the authorities do not include any limit figure. For the others, it suggests low wattage (e.g. maximum of 150W for home security lights), well-directed lights (e.g. shielded lamps) and the right choice of lighting: warm colour tones (less than 2700 K) are to be chosen and Passive Infra Red motion sensor is to be used when possible. Lastly, the lights shall be dimmed or switched off when not necessary.

Ireland has no legislation regarding light pollution and every proposed development project is considered on a case by case basis. However, in 2018 Dark Sky Ireland was founded, a partnership of stakeholders, academics, park representatives, astronomy clubs and special interest groups to raise awareness. Since then, a program called Dark Skies For All was started, to organize events, regarding policy development, education and public outreach elements. Ireland has two Dark Sky Parks: Kerry International Dark Sky Reserve and Mayo International Dark Sky Park. These Dark Sky parks allow raising awareness through tourism.

69 https://www.mayodarkskypark.ie/images/pdf/Protecting_the_NightGM_lowres.pdf

Fig. 30: Ireland's sky brightness

Fig. 31: Ireland's night lights

Italy

Legislation	
Law	Act No. 751 (1996)[70] Regional laws against light pollution: Lombardia 17/00 (updated in 2015)[71], Emilia-Romagna 113/03, Marche 10/02, Lazio 23/00, Campania 13/02, Veneto 22/97 (updated in 2009)[72], Toscana 37/00, Piemonte 31/00 (updated in 2018)[73], Valle d'Aosta 17/98, Basilicata 41/00, Abruzzo 12/05, Umbria 20/05, Puglia 15/05, Friuli-Venezia Giulia 15/07, Liguria 22/07
Decree	
Standard	Technical standard, UNI 10819:2021 Light and lighting - External lighting systems - lighting engineering quantities and calculation procedures for evaluating the upward dispersion of the luminous flux
Publication	
Manual	X
Other	
Dark-Sky Area	X
Website	X

Regional laws against light pollution have been already enforced in 15 Italians regions. The law of Regione Veneto was the first law against light pollution enforced in Italy[74]. A national Italian Act No. 751 (1996) provides specific guidelines and standards concerning lighting in order to avoid unnecessary upward illumination and reduce glare.

A technical standard, UNI 10819:2021 Light and lighting - External lighting systems - lighting engineering quantities and calculation procedures for evaluating the upward dispersion of

70 https://cielobuio.org/cielobuio/leggi/legge751.htm
71 https://cielobuio.org/applicazione-e-rispetto-della-lr-della-lombardia-3115-ex-1700
72 https://cielobuio.org/articolo-1036
73 https://www.regione.piemonte.it/web/temi/sviluppo/sviluppo-energetico-sostenibile/inquinamento-luminoso
74 http://www.lightpollution.it/cinzano/en/page95en.html

the luminous flux defines methods for calculation and verification of the upwards directed luminous flux from outdoor artificial light sources. It was elaborated by the UNI (Italian National Standards Institute), the Italian Astronomical Society's Light Pollution Committee, lighting engineers and representatives of lighting manufacturers[75]. It can be used to verify compliance of a lighting system with any technical/ legislative prescriptions and includes the following areas of application:

- lighting systems in outdoor workplaces (ref. UNI EN 12464-2);
- street lighting systems (ref. UNI 11248, UNI EN 13201 and UNI / TS 11726);
- outdoor lighting systems for fields and sports areas (ref. UNI EN 12193);
- monumental and architectural lighting systems;
- lighting systems for the external areas of residential buildings;
- lighting systems for the outdoor areas of parks and gardens;
- illuminated signs and advertising systems illuminated in outdoor areas;
- calculation methods for light intrusion.

In Emilia-Romagna, the Directorate General for the Environment and Soil and Coastal Defense, Atmospheric, Acoustic and Electromagnetic Remediation Service issued Rules for the minimization of light pollution and energy savings in 2010. These rules contain examples of correct lighting installations and technical parameters (with the exception of CCT)[76].

The Regional Environmental Agencies provide submissions for Lighting Plans. They also carry out inspections with measurements of illuminance on the windows and luminance of the exposed walls in case of complaints on obtrusive lighting.

The Province of Bolzano in 2011 issued technical directives to regulate public lighting systems in the provincial territory, with the aim of achieving high standards of energy efficiency and containment of light pollution. Municipal administrations and other entities managing more than 50 light points are obliged to draw up a lighting plan to program the adaptation of lighting systems in favour of full-cut-off lamps.

The Basilicata Region was a part of a Night Light Interreg Project[77], aiming at reducing light pollution and protecting night skies by improving local policies, where regional authorities in Netherlands, Hungary, Spain, Luxembourg, Denmark, Slovenia and Italy participated.
The Municipalities of Asiago and Cornedo all'Isarco took part in the Skyscape Interreg project[78] aimed at developing tourism observing the sky including in the city.

75 https://www.cambridge.org/core/journals/symposium-international-astronomical-union/article/local-and-national-regulations-on-light-pollution-in-italy/4513FF8C716B992ED12544FFA4C13766
76 https://bur.regione.emilia-romagna.it/bur/area-bollettini/bollettino-ufficiale-11-marzo-2010-1/modifiche-ed-integrazioni-alla-determina-del-direttore-generale-n.-14096-del-12-10-2006-circolare-esplicativa-delle-norme-in-materia-di-riduzione--dellinquinamento-luminoso-e-di-risparmio-energetico/testo-coordinato-della-circolare-inquinamento-luminoso-con-le-modifiche-apportate-dalla-ddg-1431-2010
77 https://www.interregeurope.eu/find-policy-solutions/stories/night-light-the-unexpected-potentials-of-a-dark-night-sky
78 https://keep.eu/projects/22535/Astronomical-tourism-the-be-EN/

Fig. 32: Italy's sky brightness

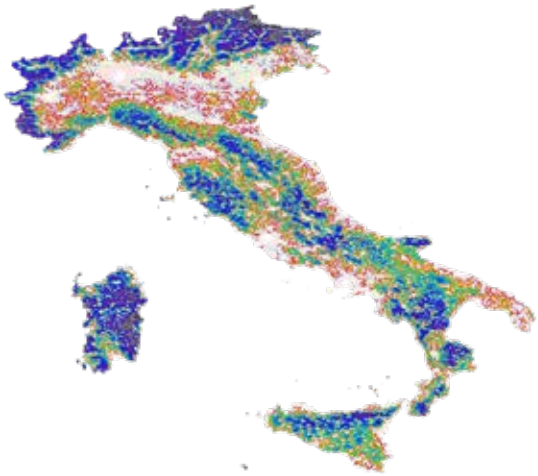


Fig. 33: Italy's night lights

Latvia

Legislation	
Law	Protection Zone Law (1997)[79] • Article 23.2. Protection zones around optical telescopes and radio telescopes • Article 51. 1. Restrictions on protection zones around optical telescopes and radio telescopes In preparation: roadside advertising and information objects regulation (The Ministry of Transport)
Decree	Cabinet regulation No. 402 (2005)[80] : Regulations regarding the Placement of Advertising Objects or Information Objects
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	X
Project	Jurmala – Jomas street
Website	https://rpr.gov.lv https://www.daba.gov.lv

Protection Zone Law (1997) determines protection zones around optical and radio telescopes and lighting parameters that shall be met in these areas.

79 https://likumi.lv/ta/en/en/id/42348-protection-zone-law
80 https://likumi.lv/ta/id/110209-noteikumi-par-reklamas-objektu-vai-informacijas-objektu-izvietosanu-gar-celiem-ka-ari-kartibu-kada-saskanojama-reklamas

Cabinet regulation No. 402 relates to conditions for the placement of advertisements and the procedure for their coordination. Advertising and information objects must not dazzle drivers and other road users. There is however no specification of what "dazzle" means and which lighting parameters affect it.

In the LUCIA (energy efficient urban lighting experts) pilot project in Jurmala[81], Jomas street was chosen for renovation of the street illumination by replacing luminaires and installing smart motion sensors.

In 2020, Latvian State roads ordered a study "Investigation of the effects of luminance and other factors on road users, definition of limit values for luminance and other parameters and development of a methodology for their measurement"[82], which aimed to determine the maximum illuminance characteristics of various roadside light objects at which road users can safely move on the roads, develop guidelines for measuring these parameters and proposals to be incorporated into regulatory provisions. Based on this study, the Ministry of Transport issued a draft regulation in 2022 which sets out requirements for roadside advertising and information objects. The purpose of the regulation should be the determination of the permissible light intensity of objects in order to prevent the danger of emitting light. This regulation determines the brightness of the maximum permitted light, as well as stipulates that light objects may not emit light from 11 p.m. to 7 a.m. in places where the light shines into the windows of residential houses. Advertising and information objects shall not emit more than 5000 cd of light during daylight hours. The maximum brightness of these objects during the dark hours of the day will be determined based on their location. The public discussion about the draft regulation is still ongoing and the content of the regulation is subject to change.

Fig. 34: Latvia's sky brightness

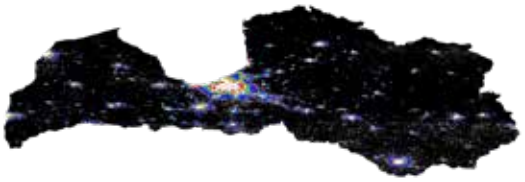
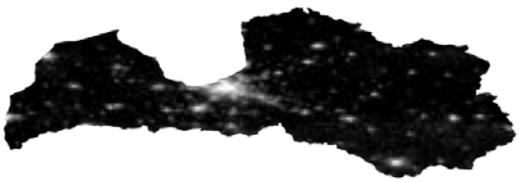


Fig. 35: Latvia's night lights



81 https://lucia-project.eu/pilot-sites/jurmala-latvia/

82 http://petijumi.mk.gov.lv/node/3402

Liechtenstein

Legislation	
Law	Environment Protection Act ("Umweltschutzgesetz", 2008)[83]
Decree	X
Standard	SIA 491 "Vermeidung unnötiger Lichtemissionen im Aussenraum" (SN 586 491:2013 (SIA 491)
Publication	
Manual	"Recommendations on reducing light emissions" (2021)[84]
Other	
Dark-Sky Area	X
Project	X
Website	https://www.llv.li/inhalt/11573/amtsstellen/lichtverschmutzung

There is no specific legislation concerning light pollution in Liechtenstein. The Environment Protection Act (EPA) contains a general provision that "emissions are limited as much as technology and operating conditions allow, provided that this is economically acceptable" (Art. 14 EPA), which also applies to light emissions. As Art. 14 of Liechtenstein's EPA has a very similar wording to Art. 11 of Switzerland's EPA, Liechtenstein also applies the Swiss enforcement aid regarding light emissions (see chapter on Switzerland). The National Administration, in particular the Office of Environment as the competent authority, enforces the abovementioned guidelines in private and public construction, supports the municipalities and other stakeholders in implementing measures against light pollution, and is actively monitoring the situation in neighbouring countries, particularly in Switzerland. Some of the eleven municipalities of Liechtenstein have enacted local regulations concerning public and private lighting and have altered their policies with respect to the extent of street lighting during the last decades. As an example, the municipality of Planken was one of the first to turn off street lighting completely at 00h30 and continues to do so. As another example, the municipality of Balzers stipulates in its advertising regulations ("Reklamereglement") that for illuminated advertising installations a maximum luminance value of of 40 cd/m^2 at a recognition distance of 500 m may not be exceeded.

Fig. 36: Liechtenstein's sky brightness

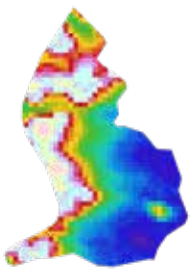


Fig. 37: Liechtenstein's night lights

83 https://www.gesetze.li/konso/2008.199
84 https://www.gesetze.li/konso/2008.199

Lithuania

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	X
Website	X

In Lithuania, there is no national policy on light pollution. However, at the city-level steps are already being taken. The City of Vilnius is one of the newest members of the LUCI (Lighting Urban Community International). In 2019, the council of the Vilnius signed up for a street lighting system renovation project. The intention was to improve lighting quality and reduce the amount of consumed electricity. Existing street light figures were replaced with new LED lamps and remote control and adjustment system was implemented.[85]

Fig. 38: Lithuania's sky brightness

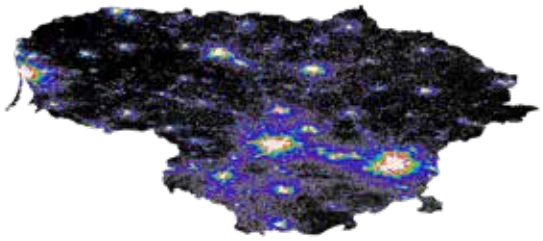


Fig. 39: Lithuania's night lights

85 https://www.tgsbaltic.com/en/deals-and-cases/vilnius-street-lighting-system-renovation/

Luxembourg

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	"Good light" guidelines for outdoor use (2018)[86]
Other	
Dark-Sky Area	X
Website	www.emwelt.lu

There is no specific legislation concerning light pollution. Awareness is raised through the "Good light" manual, which contains recommendations for light pollution reduction in municipalities, planning offices and actions of individuals. However, these are not linked to nature protection in contrast to the material presented by the government.[87]

Type building codes of municipalities state that urban lighting shall be conceived in such a way to limit the general light pollution, especially the pollution of the night sky and disturbances with a detrimental effect on human health and ecosystems. These Type building codes also contain recommendations for municipalities' demands on billboards and advertisement signs (distance to inhabited buildings and max. luminance, obligatory switch off at night time 22:00 – 6:00).[88]

Nature Park Our was a part of the Night Light Interreg Project[89], together with regional authorities from regional authorities in Netherlands, Hungary, Spain, Denmark, Slovenia and Italy. There are a range of activities for the promotion of night starry sky visibility, for the general public as well as for professionals. Since 2019, there is a consultancy centre in the NP Our providing guidance on correct lighting appliances.

Fig. 40: Luxembourg's sky brightness

Fig. 41: Luxembourg's night lights

86 https://environnement.public.lu/content/dam/environnement/actualites/2018/06/Leitfaden-fur-gutes-Licht-im-Aussenraum.pdf
87 https://environnement.public.lu/dam-assets/documents/natur/biodiversite/infrastructures-vertes/pollution-lumineuse-GDL-mai2021-BD-planches.pdf
88 https://www-meco-lu.translate.goog/de/blog/documentcenter/reduktion-der-lichtverschmutzung-in-luxemburg-anregungen-des-mouvement-ecologique-und-des-oekozenter-pafendall/?_x_tr_sl=auto&_x_tr_tl=cs&_x_tr_hl=cs
89 https://www.interregeurope.eu/find-policy-solutions/stories/night-light-the-unexpected-potentials-of-a-dark-night-sky

Malta

Legislation	
Law	Development Planning Act (Cap. 552) (2016)[90] Environment Protection Act (Cap. 549) (2016)[91]
Decree	Development Notification Order (SL 552.08) (2021)[92]
Standard	Billboards and Advertisements Regulations (SL 552.28) (2004)[93]
Publication	
Manual	Guidelines for the Reduction of Light Pollution in the Maltese Islands (2020)[94]
Other	
Strategy	Strategic Plan (SPED, 2017)[95] Gozo and Comino Local Plan (2006)[96] North West Local Plan (2006)[97]
Website	https://www.guidememalta.com/en/magical-the-best-stargazing-locations-in-malta-for-the-happy-astronomer

Malta has policies in place which seek to limit light pollution. The Spatial Plan for Environment and Development (SPED) is a strategic spatial plan for the Maltese Islands. This document approved by the Maltese Parliament gives strategic spatial direction applicable to the whole territory and the territorial waters. Light pollution is referred to in Thematic Objective 8.9. Subsidiary spatial planning documents emerge from strategic spatial direction. Two of the subsidiary plans refer to light pollution - the Gozo and Comino Local Plan ((Policies GZ-UTIL-5 section 8.2.3 and GZ-DARK-1) section 13.8) and the North West Local Plan (sections 14.6.11 to 14.6.13). Furthermore, the Development Control Design Policy, Guidance and Standards (2015) and the Development Notification Order (SL 552.08) control lighting for development applications[98] (Design Guidance G27); and the Billboards and Advertisements Regulations (SL 552.28).

In line with the provisions of the Development Planning Act (Cap. 552) and the Environment Protection Act (Cap. 549), the Planning Authority and the Environment and Resources Authority drafted Guidelines for the Reduction of Light Pollution in the Maltese Islands which includes a chapter on the legal and policy framework in Malta. These Guidelines are being revised following public consultation.

Additionally, road lighting, which is defined as: "fixed lighting installations intended to provide good visibility to users of outdoor public traffic areas during the hours of darkness to support traffic safety, traffic flow and public security" is one of the product groups within the scope of Green

90 http://extwprlegs1.fao.org/docs/pdf/mlt196820.pdf
91 https://era.org.mt/wp-content/uploads/2019/05/CAP_549.pdf
92 https://legislation.mt/eli/sl/552.8/eng/pdf
93 https://legislation.mt/eli/sl/552.28/eng/pdf
94 https://era.org.mt/wp-content/uploads/2020/06/Guidelines-for-the-Reduction-of-Light-Pollution-in-the-MI-PC-Draft.pdf
95 https://issuu.com/planningauthority/docs/sped_approved_doc__1_
96 https://www.pa.org.mt/file.aspx?f=8F0DB0BB569DF5B7A6C19C78570B4FE6B1F55AC49A65498A
97 https://www.pa.org.mt/file.aspx?f=A23294A474B5B7E1AD8CBF4B4F6E51E28CD349C08C53498A
98 https://issuu.com/visitmalta/docs/dc2015

Public Procurement which is being updated. A national policy document governs the implementation of Green Public Procurement. Within the 2nd National Action Plan for Green Public Procurement, the procurement of lighting equipment for the following is subject to a set of environmental criteria:

- road lighting in new lighting installations;
- retrofitting of different luminaires to existing lighting installations;
- retrofitting of different light sources or controls to existing luminaires; or
- the simple replacement of light sources, lamps or luminaires on a like-for-like basis in existing lighting installations.

In many cases, where street lighting consists of LED luminaires, dimming is applied. As of 2022, all road lighting procured by the government should have a minimum dimming performance through the installation of fully functional dimming controls that are programmable to set at least one pre-set level of dimming down to at least 50% of maximum light output.

Fig. 42: Malta's sky brightness

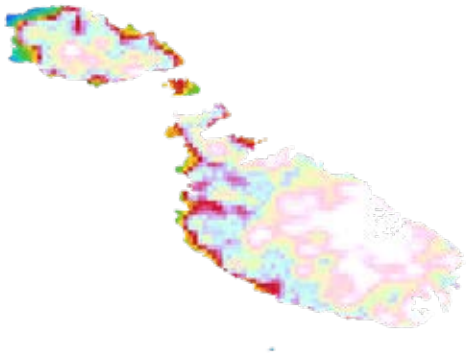


Fig. 43: Malta's night lights

Netherlands

Legislation	
Law	X
Decree	Environmental Activities Decree concerning rules about activities in the physical living environment (2018)[99] Environmental Activities Management Decree concerning general rules for the companies (2007)[100]
Standard	X
Publication	
Manual	The Light/Dark Handbook of the Association of Provincial Authorities (IPO, 2018)[101] Handbooks (2020)[102] Guideline for the governments[103]
Other	
Dark-Sky Area	East Terschelling and Lauwersmeer National Park
Website	https://www.atlasleefomgeving.nl/en/explore/night-time-illumination

The Netherlands is one of the most illuminated countries in the world. Currently, there is no national policy on light pollution. However, decentralised regulations have been brought up by a number of local provincial governments and municipalities. Policy on protecting the darkness is the result of the protection of Natura 2000 areas. The reason for night-time lighting regulations is usually to save energy. The topic of light pollution has been well described in the Environmental Health Atlas[104] where municipalities, provinces and the state itself publish information about the living environment in the country. There are also maps that illustrate the lighting conditions so every citizen can check the situation in the neighbourhood.

The Environmental Activities Decree currently offers regulations to reduce the nuisance caused in residential areas by lighting used in the greenhouse horticulture sector. The cultivation of crops in greenhouses is designated as an environmentally harmful activity that shall follow the rules on assimilation lighting. Other activities such as industry or agriculture (that have a considerable impact on the environment) shall take the environment into consideration and take all reasonable measures to prevent or minimise adverse impacts The Environmental Activities Management Decree regulates sources of sports-related lighting. It sets exact conditions of when the lighting of an outdoor sports venue must be turned off - between 23.00 and 7:00 and if no sport is practiced or maintenance takes place. The Decree is going to be replaced by The Environmental Activities Decree.

99 https://iplo.nl/publish/pages/195439/the-environmental-activities-decree-of-3-july-2018.pdf
100 https://rwsenvironment.eu/subjects/environmental-0/activities-decree/
101 https://www.rivm.nl/handboek-lichtdonker
102 https://bekendmakingen.amsterdam.nl/bekendmakingen/publicatie/inspraak/feestverlichting/
103 https://iplo.nl/thema/licht/lichthinder/
104 https://www.atlasleefomgeving.nl/en

The Dutch Ministry of Infrastructure and Water Management has also begun turning off lights along sections of highway where fewer than 50 cars per hour pass. Many municipalities are adopting smarter lighting that is directed downwards, dimmed, and often has a warmer tint.

In the Night Light Interreg EU project, regional authorities in Netherlands, Hungary, Spain, Luxembourg, Denmark, Slovenia and Italy endeavour to reduce light pollution and protect night skies by improving local policies.[105]

Nacht van de Nacht (Night of the Night) is an annual event that takes place in October in numerous cities of the Netherlands where local governments and companies turn off their lights. The goal of this event is to change lighting habits permanently to make the country darker and more sustainable.[106]

SEEING STARS (2021) was a site-specific exhibition that took place in the city of Franeker in Friesland. Its point was a controlled switching-off of city lights and non-essential lighting. This project was a collaboration between UNESCO Netherlands, Studio Roosegaarde, the residents, government and businesses.[107]

Fig. 44: Netherlands's sky brightness

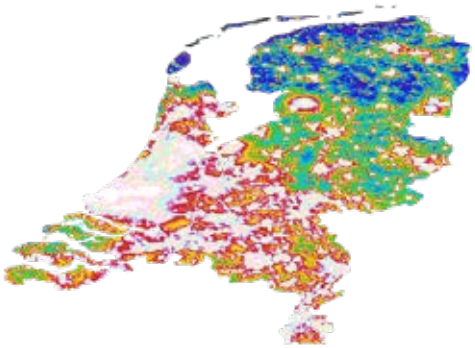


Fig. 45: Netherlands's night lights

105 https://www.interregeurope.eu/find-policy-solutions/stories/night-light-the-unexpected-potentials-of-a-dark-night-sky
106 https://www.nachtvandenacht.nl/
107 https://www.studioroosegaarde.net/project/seeing-stars

Norway

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	Outdoor City Lighting (2012)[108]
Other	
Dark-Sky Area	X
Website	X

There is no legislation directly for light pollution, however parts of already existing laws contain provisions that can be used - Neighbourhood Law, the Biodiversity Act, Area Protection, the Pollution Control Act, the Planning and Building Act and the Public Health Act[109].

The use of outdoor lighting cannot be regulated through the Planning and Building Act, but regulations can be issued that limit light pollution. Zoning plans may have provisions that limit the number of outdoor lighting and that the lights shall be limited to the entrance area. Provisions can be made for outdoor lighting to have a luminaire that is directed downwards, and requirements for the use of lighting control systems that ensure that the light is dimmed or switched off at night. Provisions can also be made for CCT to limit the scattering of light. Street lighting should not be allowed outside any downtown areas.

A Manual containing overall advice on how to plan and design municipal lighting systems was issued in 2012 by the Transport Ministry, Ministry of Communal and Regional Affairs and Ministry of the Environment and Development. It is not concerned in great detail with measures to limit light pollution – correlated colour temperature (CCT), shielding, upward light ratio (ULR), etc., however, dimming is described.

Ringsaker municipality, known for its high concentration of second homes, issued rules for minimizing light pollution for property owners, applicable to all lighting, regardless of the energy source[110]:

- as few light sources as possible; max. three light sources per property;
- only lighting the entrance area, not roads or parking lots;
- only downwards-oriented light and shielded;
- as low brightness as possible, max. 470 lumens;
- warm CCT, max 2700 K;
- switching off when the property is not in use.

108 https://www.regjeringen.no/contentassets/52dc5ce489734c959e079471b0757dec/t-1512.pdf
109 https://www.duo.uio.no/bitstream/handle/10852/61565/205.pdf?sequence=1&isAllowed=y
110 https://www.nrk.no/innlandet/bjonnasen-hytteomrade-i-ringsaker-innforer-kraftige-tiltak-mot-lysforurensning-1.15734433

Fig. 46: Norway‘s sky brightness

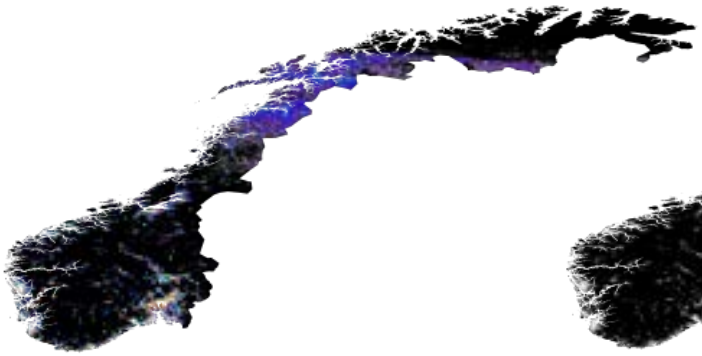


Fig. 47: Norway‘s night lights

Poland

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	Izerski Park Ciemnego Nieba[111], Biesczady Starry-Sky Park, East Carpathian Dark-Sky Tripark
Website	https://ciemneniebo.pl/pl/ https://goodlightlaw.im.edu.pl

In Poland, there is no national policy on light pollution. However, there are awareness raising initiatives connected to areas of dark sky - Izerski Park Ciemnego Nieba, which is located in Poland and the Czech Republic, Biesczady Starry-Sky Park and East Carpathian Dark-Sky Tripark.

Fig. 48: Poland‘s sky brightness

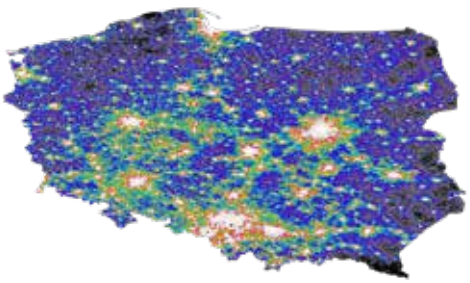


Fig. 49: Poland‘s night lights

111 http://www.izera-darksky.eu/index-pl.html

Portugal

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	The Manual of light pollution[112]
Other	
Dark-Sky Area	Alqueva Dark Sky Reserve
Website	X

Portugal has no legislation regarding light pollution. However, astrotourism is expanding, especially due to the Dark Sky Alqueva Observatory. Thanks to this type of tourism, awareness about light pollution is increasing in the public sphere. Moreover, the scientific community pressures the government to regulate the issue and carries out research on the topic[113, 114].

The Manual of light pollution[115] gives information about how to measure sky glow and estimate the level of light pollution. It also follows important legislation in other European countries (especially in Spain) regarding light pollution. Finally, it presents two case studies, analysing different situations of light pollution and how to prevent them.

Fig. 50: Portugal's sky brightness

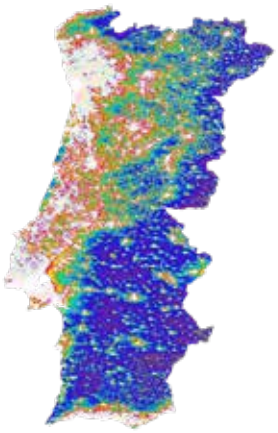


Fig. 51: Portugal's night lights

112 https://encpe.apambiente.pt/sites/default/files/documentos/4%20-%20manual_poluicao_luminosa_cpi.pdf
113 https://eg.uc.pt/bitstream/10316/80218/1/Light%20pollution%20Assessment%20of%20sky%20glow%20on%20two%20dark%20sky%20regions%20of%20Portugal.pdf
114 https://www.unoosa.org/documents/pdf/psa/activities/2021/DQS2021/Day2/Sess8/D2S8_3_ALWG_Lima_converted.pdf
115 https://encpe.apambiente.pt/sites/default/files/documentos/4%20-%20manual_poluicao_luminosa_cpi.pdf

Romania

Legislation	
Law	X
Decree	X
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	X
Website	http://www.mmediu.ro/

In Romania, the topic of light pollution is relatively new and so far, there is no regulation that concerns it. However, the Environment Fund Administration runs a Programme on Increasing the Energy Efficiency of Public Lighting Infrastructure, which aims to reduce greenhouse gas emissions by using more energy-efficient LED lighting fixtures.

Fig. 52: Romania‘s sky brightness

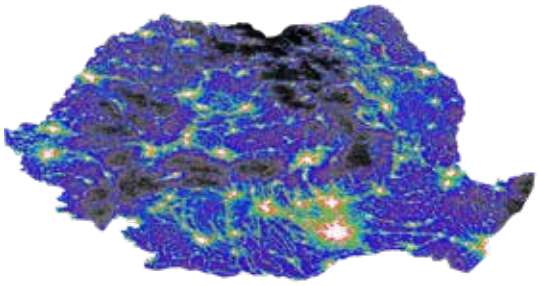
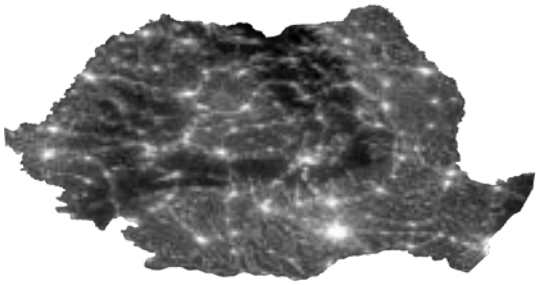


Fig. 53: Romania‘s night lights



Slovakia

Legislation	
Law	Act on the Protection, Promotion and Development of Public Health and on Amendments to Certain Acts (2007)[116]
Decree	Decree of the Ministry of Health of the Slovak Republic on details of limit values of optical radiation and requirements for objectification of optical radiation in the environment (2007)[117]
Standard	X
Publication	
Manual	X
Other	
Dark-Sky Area	Poloniny, Veľká Fatra Dark-Sky Park, East Carpathian Dark-Sky Tripark
Website	https://svetelneznecistenie.sk https://sas.astro.sk/o-nas/sekcie/sekcia-ochrany-pred-svetelnym-znecistenim/

Slovakia has had a law since 2007 and a subsequent Decree setting limit values for artificial lighting. Limit values are based on CIE (International Commission on Illumination). However, there has been no update since 2007. Poloniny Dark Sky Park, East Carpathian Dark-Sky Tripark and Veľká Fatra Dark-Sky Park have been declared, thanks to initiatives both from the scientific and activist sphere. Moreover, academics have been pointing out the issue of light pollution and its effects on fauna and flora for a long time through articles as well as presentations intended for the public.

Fig. 54: Slovakia's sky brightness

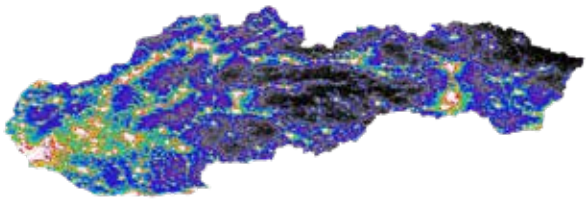


Fig. 55: Slovakia's night lights

116 https://www.uvzsr.sk/docs/leg/355_2007_en.pdf
117 https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2007/539/

Slovenia

Legislation	
Law	X
Decree	Decree on limit values due to light pollution of environment Issued in March 2007[118], amended in 2007, 2010[119] and 2013[120], update in preparation (2023)
Standard	X
Publication	
Manual	Nature-friendly lighting of cultural heritage sites (2014)[121] Lighting of adveritsing objects (2011)[122]
Other	
Dark-Sky Area	X
Website	https://www.gov.si/teme/svetlobna-obremenitev-okolja/

Slovenia has had a Decree on light pollution limit values since 2007. The Decree has undergone several updates and now the limit for the CCT is being considered and it is planned to reduce or turn off lighting during the night. Limits are currently set, for example, for upward light output ratio (ULR), intensity or time range when lighting can be in operation. The decree should be updated in 2023. Slovenia also has a strong "Dark Sky" initiative, which draws public attention to the problem of light pollution.

There are two Manuals addressing light pollution. The first one reminds the Slovenian legislation and the measures taken to reduce light pollution and to protect animal species and their habitat, including the negative impact of LED lamps on fauna. It also mentions the impact of light pollution on the environment, especially on animals (e. g. bats, moths and butterflies). Moreover, it presents the project Life at Night that is interested in the impact of church lighting on nocturnal life. Finally, it sets recommendations for respectful lighting of cultural sites.

The second Manual contains details of the limit values and restrictions that were given in the 2007 Decree. An advertising space may be lit only if it is located in an area already lit with public or road lighting and may not be further than 60m from the illuminated area. It also sets the electrical output of all indoor luminaires for advertising space lighting that must not exceed the specified limits, determined according to the size of the advertising space.

In the Night Light Interreg EU project, regional authorities in Netherlands, Hungary, Spain, Luxembourg, Denmark, Slovenia and Italy endeavour to reduce light pollution and protect night skies by improving local policies.

118 http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED4520
119 https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina/2010-01-3504?sop=2010-01-3504
120 https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina/2013-01-1760?sop=2013-01-1760
121 http://www.temnonebo.si/images/pdf/naravi_prijaznejsa_razsvetljava_brosura_web.pdf
122 http://www.temnonebo.si/images/pdf/brosura%20osvetljevanje%20objektov%20za%20oglasevanje_splet.pdf

Fig. 56: Slovenia‘s sky brightness

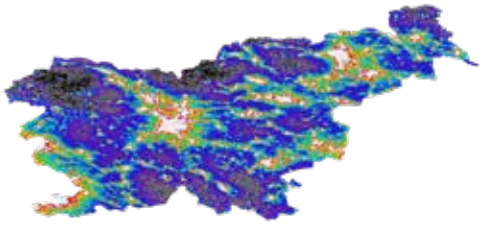


Fig. 57: Slovenia‘s night lights

Spain

Legislation	
Law	Regulation for Air Quality and Protection of the Atmosphere (additional provision to promote prevention and reduction of light pollution) (2007)[123] Environmental Assessment Law (only includes light emissions in the Study of the Environmental Impact) (2013)[124]
Decree	Decree Approval of the Regulation on Energy Efficiency in Outdoor Lighting Installations and its Complementary Technical Instructions EA-01 to EA-07 (2008)[125]
Standard	X
Publication	
Manual	Practical Guidelines for Outdoor Lighting (2019)[126] Requirements of Road Lighting (2015)[127] Technical specification of outdoor LED lighting Fixtures (2020)[128]

123 https://www.global-regulation.com/translation/spain/1445081/law-34-2007-of-15-november-on-air-quality-and-atmospheric-protection.html
124 https://www.boe.es/buscar/act.php?id=BOE-A-2013-12913
125 https://www.global-regulation.com/translation/spain/1444142/royal-decree-1890---2008-of-14-november%252c-which-approves-the-regulation-of-energy-efficiency-in-outdoor-lighting-and-their-complementary-technical-in.html
126 https://www.iac.es/en/documents/guia-practica-de-iluminacion-de-exteriores
127 https://www.mitma.gob.es/recursos_mfom/oc362015_tomoi.pdf
128 https://www.idae.es/sites/default/files/documentos/idae/tecnologias/ahorro_y_eficiencia_energetica/alumbrado_exterior/requerimientos_tecnicos_exigibles_alumbrado_exterior_dic-2020.pdf

Other	
Dark-Sky Area	IDA Dark Sky Park (DSAG Class 2c): Albanyá Starlight Foundation Reserves (DSAG Class 1): Cielos de Guadalajara, Parque Regional de Gredos, Sierra de Albarracín, Menorca, Comarca Cuencas Mineras, Parque Nacional de Aigüestortes i Estany de Sant Maurici, Los Pedroches, Territorio Gúdar-Javalambre, Fuerteventura, Sierra Sur de Jaén, Sierra Morena Andaluza, El Montsec, Cumbres de Tenerife, La Palma. Starlight fundation Tourism destinations (DSAG Class 2c): La Manchuela, Comarca de Las Hurdes, Sierra de Cádiz, Valle del Alto Guadiato, Allande, Tierra Bobal, Serranía de Cuenca, Lerín, Muntanyes de Prades i Serra de Montsant, Sierra del Segura, Sierra de Alcaraz y Campo de Montiel, Muras, Fuencaliente de La Palma, Sierra de Albarracín, Valle de Alcudia y Sierra Madrona, La Matanza de Acentejo, Menorca, Alto Turia, Comarca Cuencas Mineras, Parque Nacional de Aigüestortes Estany de Sant Maurici, Muriel Viejo, Gran Canaria, Serranía de Cuenca, Valle del Roncal, Territorio Gúdar-Javalambre, Monfragüe, Parque Nacional Das Illas Atlánticas de Galicia, Trevinca, Sierra Sur de Jaén, Sierra Morena Andaluza, El Teide, Gredos Norte, El Montsec, Granadilla de Abona, Reserva de la Biosfera Valles de Leza, Jubera, Cidacos y Alhama. Other (DSAG Class 1): Observatorio de Sierra Nevada
Website	https://guaix.fis.ucm.es/reecl/legislacion

Spain has legislation concerning light pollution, completed by concrete laws and decrees in each autonomous community. In particular, the Canary Islands have specific restrictions due to the presence of the Astrophysical Institute. The Royal Decree of 2008 specifies the minimum requirements (but no minimum values for lighting levels) for energy efficiency in functional street lighting installations in order to improve light efficiency and reduce light pollution. Regulations concern installations of more than 1 kW input, concrete requests regarding light intensity and CCT (the measures are specified for each types of outdoor installations). An update of the Decree is being drafted.

In July 2021, a Second Public Hearing Procedure took place to review a draft update of this Decree that considers recent technological progress such as LED technologies and lighting regulation systems, which can increase energy efficiency of lighting installations.

Specific laws have been issued for each autonomous community:

- Canary Islands: Law No. 31/1988. Protection of the Astronomical Quality of the Observatories of the Institute of Astrophysics of the Canary Islands.
- Castilla y León: Law No. 15/2010. Prevention of Light Pollution and Promotion of Energy Savings and Efficiency Derived from Lighting Installations.
- Cantabria: Law No. 6/2006. Light pollution Prevention Law.
- Andalucía: Law No. 7/2007. Integrated Environmental Quality Management Law.
- Balearic Islands: Law No. 3/2005. Law for the Protection of the Night Environment.
- Navarra: Law No. 10/2005. Law Regulating Lighting for the Protection of the Nightlife.
- Extremadura: Law No. 5/2010. Law of Prevention and Environmental Quality.
- Cataluña: Law No. 6/2001. Environmental Planning of Lighting for the Protection of the Night Environment.

Specific Decrees have been issued for each autonomous community:

- Navarra: Decree No. 199/2007. Decree for the Protection of the Nightlife.
- Cantabria: Decree No. 48/2010. Decree for the Prevention of Light Pollution.
- Canary Islands: Decree No. 243/1992. Protection of the Astronomical Quality of the Observatories of the Canary Islands.
- Andalucía: Decree No. 75/2014. Regulation for the Protection of the Quality of the Night Sky Against Light Pollution and the Establishment of Energy Saving and Efficiency Measures. (new legislation is in process)
- Cataluña: Decree No. 190/2015. Environmental Planning of Lighting for the Protection of the Night Environment.

The abovementioned manual contains information about different types of luminaires, the impact of light pollution on human health and on the environment as well as recommendations for efficient and environmentally friendly lighting:

- avoid excesses in lighting levels and emission of light directly toward the sky
- do not use lamps with radiation less than 500 nm (i.e. no blue or UV lights) and if white light is necessary, use warm white LEDs (<2700 K)

The La Palma and Avila regional authorities participated in the Night Light Interreg Project[129] (together with authorities in Netherlands, Hungary, Luxembourg, Denmark, Slovenia and Italy), aiming at reducing light pollution and protecting night skies by improving local policies, and in the Pirineos la Nuit[130] Interreg project for safeguarding the night sky in the Pireneos mountains.

Fig. 58: Spain‘s sky brightness

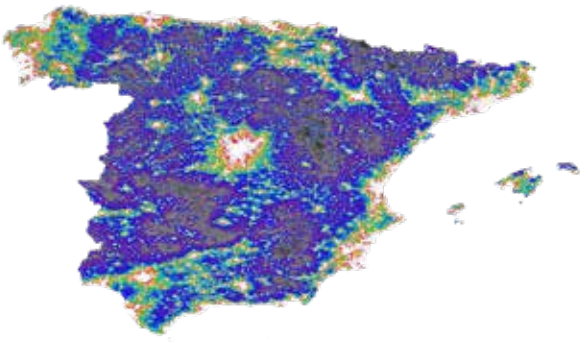


Fig. 59: Spain‘s night lights

129 https://www.interregeurope.eu/find-policy-solutions/stories/night-light-the-unexpected-potentials-of-a-dark-night-sky
130 https://pirineoslanuit.org/fr/pirineos-la-nuit-fr2/

Sweden

Legislation	
Law	Planning and Building Act (2010)[131] Environmental Code (2000)[132]
Decree	TSFS 2021:122 The Swedish Transport Agency's regulations and general advice on property requirements for roads, streets, trams and metros (building regulations) (2021)[133]
Standard	SS-EN 13201-2 Road lighting — Performance requirements (annex about obtrusive light) (2003)
Publication	
Manual	VGU Recommendations for the design of roads and streets (2022)[134]
Other	
Dark-Sky Area	X
Website	X

Light pollution has so far not been a central issue in planning and environmental assessments, however awareness is gradually increasing about the effects of light pollution on human health and the environment. Lighting, light and its effect on human health and the environment are regulated by several different pieces of Swedish legislation. For example, provisions in the Environmental Code can be useful for considering or limiting light pollution and the Planning and Building Act has regulations about light, signs and lighting devices.

The Swedish Transport Agency has issued regulations and general advice[135] on requirements for roads, streets, trams and metros (building regulations) stating that lighting must be designed in a way that light pollution is limited to reduce negative effects on wildlife. Light pollution affecting photosensitive and endangered or protected species should be specifically limited. Lighting should be designed to minimize barrier effects (barriers for animals' natural movement patterns), for example by reducing the spatial scattering from light sources or reducing the lighting during off-peak hours.

The Swedish Transport Administration draws up requirements and recommendations for the design of roads and streets, VGU. There are plans of turning the recommendations concerning lighting[136] into requirements for state roads.

131 https://www.climate-laws.org/geographies/sweden/laws/the-building-and-planning-act-sfs-2010-900
132 https://www.government.se/49b73c/contentassets/be5e4d4ebdb4499f8d6365720ae68724/the-swedish-environmental-code-ds-200061
133 https://www.transportstyrelsen.se/sv/Regler/ts-foreskrifter-i-nummerordning/2021/details?RuleNumber=2021:122&ruleprefix=TSFS
134 http://trafikverket.diva-portal.org/smash/get/diva2:1621302/FULLTEXT03.pdf, p. 458-460
135 https://www.transportstyrelsen.se/sv/Regler/ts-foreskrifter-i-nummerordning/2021/details?RuleNumber=2021:122&ruleprefix=TSFS
136 http://trafikverket.diva-portal.org/smash/get/diva2:1621302/FULLTEXT03.pdf, p. 458-460

The Swedish Energy Agency funds research projects concerning energy-efficient and functional lighting in which light pollution is a part. The SLU Swedish Biodiversity Centre has highlighted light pollution in knowledge overviews. Various county administrative boards have started to look at the issue in areas such as work on green infrastructure and species protection. Several municipalities have lighting strategies or guidelines for public lighting.

Fig. 60: Sweden‘s sky brightness

Fig. 61: Sweden‘s night lights

Switzerland

Legislation	
Law	Environmental Protection Act (1983)[137] Nature and Cultural Heritage Act (1966)[138]
Decree	X
Standard	Die Norm SIA 491 ”Vermeidung unnötiger Lichtemissionen im Aussenraum” (SN 586 491:2013 (SIA 491))
Publication	
Manual	Enforcement aid: “Recommendations on reducing light emissions” (2021) in German[139] and French[140]
Other	
Dark-Sky Area	Sternenpark Gantrisch[141] (Dark-Sky Park certification process ongoing)
Website	https://www.bafu.admin.ch/bafu/de/home/themen/elektrosmog/fachinformationen/lichtemissionen--lichtverschmutzung-.html

137 https://www.fedlex.admin.ch/eli/cc/1984/1122_1122_1122/en
138 https://www.fedlex.admin.ch/eli/cc/1966/1637_1694_1679/en
139 http://www.bafu.admin.ch/uv-2117-d
140 http://www.bafu.admin.ch/uv-2117-f
141 https://www.sternenpark-gantrisch.ch/

The Federal Office for the Environment (FOEN) published in October 2021 a so-called "Vollzugshilfe" (enforcement aid) regarding light emissions (Enforcement aid Nr. 2117 "Recommendations on reducing light emissions"). These guidelines are intended to help limit light emissions in accordance with legislation such as the Environmental Protection Act (EPA) and the Nature and Cultural Heritage Act (NCHA). They should enable those involved in the planning, evaluation, approval and operation of lighting to take the measures required to avoid or minimise light emissions. However, this enforcement aid does not create any new legal basis.

Three political levels share power in Switzerland: the Confederation, the 26 cantons and 2172 communes. Cantons and communes are in charge of approving the lighting installations of, for example, cantonal or communal streets, other public spaces such as squares, public buildings, industrial premises, illuminated signs, private premises and sports infrastructure. Cantons and communes may have their own light emission regulations in order to enforce the EPA and the NCHA. Since October 2021, the new enforcement aid supports the different cantons and communes to enforce the EPA and NCHA.

Fig. 62: Switzerland's sky brightness

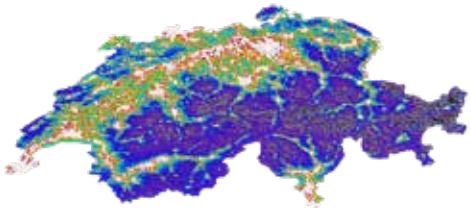


Fig. 63: Switzerland's night lights

United Kingdom

Legislation	
Law	Environmental Protection Act (1990)[142]
Decree	X
Framework	National Planning Policy Framework (revised in 2021)[143]
Publication	
Manual	Light Pollution – manual by NGO Environmental Protection UK (2013)[144]
Handbook	Blinded by the Light? A handbook on light pollution by the British Astronomical Association[145]
Other	
Dark-Sky Area	Dark-Sky parks: Northumberland National Park and Kielder Water & Forest Park (England) Elan Valley Estate (Wales) Galloway Forest Park (Scotland) Dark-Sky reserves: Brecon Beacons National Park, Snowdonia National Park (Wales) Exmoor National Park, The South Downs National Park, Cranborne Chase Area of Outstanding Natural Beauty, The Yorkshire Dales, North York Moors (England) Dark-Sky islands: Coll Dark Sky Island (Scotland) Sark Dark Sky Island (Guernsey) Dark-Sky town: Moffat (Scotland)
Website	https://www.gov.uk/guidance/light-pollution - Government advice on how to consider light within the planning system

The problem with environmental pollution caused by artificial light has been already well noted in the United Kingdom at the national, regional and local level. On the national scale, the Department for Environment, Food & Rural Affairs of the Government has cross-government oversight of light pollution policy, with other Departments including the Department for Levelling Up, Housing and Communities and the Department for Transport responsible for specific aspects of light. Artificial light can be deemed a statutory nuisance under the Environmental Protection Act 1990[146]. This gives councils the power to take action against individuals or businesses responsible for emitting artificial light from premises which is deemed to be prejudicial to health or a nuisance. Individuals can direct their complaints

142 https://www.legislation.gov.uk/ukpga/1990/43/contents
143 https://webarchive.nationalarchives.gov.uk/ukgwa/20210708211349/https://www.gov.uk/government/publications/national-planning-policy-framework--2
144 https://www.environmental-protection.org.uk/wp-content/uploads/2016/03/Light-Pollution.pdf
145 https://britastro.org/dark-skies/pdfs/CfDS_booklet_Rev07.pdf
146 https://www.legislation.gov.uk/ukpga/1990/43/contents

to the Environmental Health Department of the relevant local authority. Certain premises are exempt from the legislation (e.g. airports, prisons, stations, docks, military facilities).

The need to address the impact of light pollution through the planning system is recognised in the National Planning Policy Framework[147], which states that planning policies and decisions should limit the impact of light pollution from artificial light on local amenity, dark landscapes and nature conservation. To support the Framework, a planning practice guidance for local authorities has been published with advice on how to consider light[148].

In 2020, a parliamentary group dedicated to reducing light pollution was founded. The All-Party Parliamentary Group for Dark Skies (APPG) includes members of all parties from both the House of Commons and House of Lords. They work with major organisations, experts and communities in the UK and abroad to identify political priorities on dark sky issues, discuss lighting and planning policies and advocate for them in the UK Parliament. In the first year of existence, the APPG released a plan for combating light pollution called "Ten Dark Sky Policies for the Government"[149] . The plan includes policy recommendations that aim to update the existing legal framework regulating light pollution, establish new national lighting standards, and support dark sky preservation across the United Kingdom.

The UK has more certified international dark-sky places than any other country outside the USA and has some of the largest areas of dark sky in Europe. The Commission for Dark Skies (run by the British Astronomical Association) has played its part in supporting these initiatives. Separately, the Dark Sky Discovery Partnership's growing network of Dark Sky Discovery Sites[150] presents the best spots in rural and urban areas to see the night sky. The town of Moffat in Scotland is titled the Europe's very first Dark Sky Town.One of the numerous initiatives in the UK to combat light pollution is the countryside charity CPRE's annual citizen science event called Star Count. Every year since 2011, thousands of individuals and groups report the number of stars they can see in the Orion constellation with the naked eye. Based on the results from different locations of the UK the CPRE makes a map of starry skies.[151] In 2014 CPRE carried out a survey of local authority approaches to lighting in England called Shedding light.[152]

The Institute of Lighting Professionals is a group of lighting experts who cover a wide range of issues, including legislation and regulations that affect the built environment. They gather a range of resources on their website including lighting guides, publications, reports and presentations.[153]

147 https://www.gov.uk/government/publications/national-planning-policy-framework--2
148 https://www.gov.uk/guidance/light-pollution
149 https://appgdarkskies.co.uk/policy-plan https://static1.squarespace.com/static/5e567fb65a380a76eb3c8133/t/60c72d0311d31c3137515f31/1623665931233/APPG+for+Dark+Skies+-+10+dark+sky+policies.pdf
150 https://www.darkskydiscovery.org.uk/dark-sky-discovery-sites/map.html
151 https://www.cpre.org.uk/what-we-care-about/nature-and-landscapes/dark-skies/star-count-2021/
152 https://www.cprenorfolk.org.uk/resources/shedding-light-local-authority-approaches-to-lighting-in-england/
153 https://webarchive.nationalarchives.gov.uk/ukgwa/20210708211349/https://www.gov.uk/government/publications/national-planning-policy-framework--2

Fig. 64: United Kingdom's sky brightness

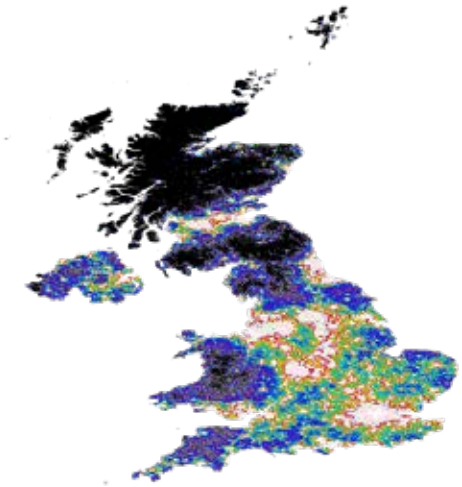


Fig. 65: United Kingdom's night lights

Case Study: Prague Lighting Masterplan

Prague, the capital of Czech Republic, decided at the end of 2019 to proceed with a conceptual and systematic approach to the management of the public and architectural lighting system. On the basis of this decision, it submitted a set of documents for processing under the title Concept of Prague Public Lighting. This set consists of three main parts: Lighting Masterplan, Renewal Plan and Standards.

The Lighting Masterplan specifies the night image of the city and its purpose is to preserve the defined night appearance of the city through the proposed parameters and rules. The Lighting Masterplan and its requirements and parameters, are intended to serve as input data for subsequent project documentation.

An analysis of the current night time picture of the city was carried out before the actual design of Lighting Masterplan. During the analysis of the night image of the city, an area analysis from night map (Fig. 1) and a spatial analysis were carried out. The night time image of Prague is generally shaped by a whole range of artificial light sources (street lighting, buildings, workplaces, sports fields, advertisements). Given that the city of Prague only manages public lighting and architectural lighting, the night image of Prague is primarily described in relation to these two types of lighting systems.

Fig. 66 Night orthogonal image of Prague (photo city of Prague)

Source: Prague City Lighting Masterplan

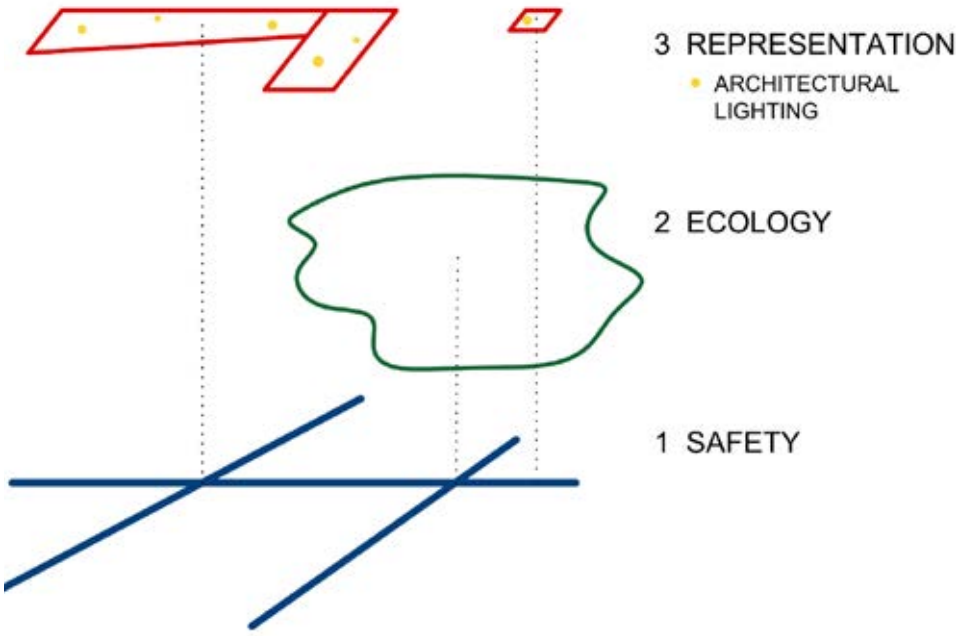
The primary purpose of public lighting is to ensure safety. The primary purpose of architectural lighting is to create a certain image of the city and its public spaces. In addition to its primary purpose, public lighting also affects the appearance of public spaces at night. At the same time, both mentioned lighting systems can adversely affect the surrounding environment through their operation. The Lighting masterplan takes into account the above facts and is divided into three basic parts:

- safety – the effect of lighting on the safety of traffic, people and property;
- ecology – the effect of lighting on the surrounding environment;
- representation – the effect of lighting on the appearance of the city and public spaces.

A very important requirement for the processing of the Lighting masterplan was the compatibility of the output data with the GIS data environment used by Prague as part of spatial planning. A GIS data layer was chosen for each of the above aspects. Attributes have been added to these layers and appropriate values or properties have been assigned to these attributes. This created the basic prerequisites for creating the data model of the Lighting masterplan. The basic layer (lines) is the safety, which sets the minimum requirements for lighting from a safety perspective. The ecology layer (polygons) complements these requirements with requirements for limiting obtrusive light. The representation layer (polygons and points) complements or

increases the basic requirements set from the safety point of view and in some exceptional cases mitigates the requirements set from the ecological point of view. The basic structure of the data model is shown in Fig. 2.

Fig. 67: Data layer schema of Prague Lighting Masterplan



Source: Prague City Lighting Masterplan

Case Study: Switching off public lighting in Brno

An illustration of the contribution of the public lighting system to the light pollution of Brno, the second biggest city of the Czech Republic, was the purpose of an experiment conducted by scientists from the Technical University Brno together with the Technical Services, the company responsible for managing the public lighting. The team of scientists are working on a device and a method for measuring light pollution and this experiment contributed to their research.

The public lights were switched off on April 10th, 2021, between 0:30 and 3:30 AM. During this period, the activity in the city was affected by the overall state of emergency declared over the Czech Republic due to the ongoing COVID-19 pandemic, thus it was supposed that the traffic would be at minimum levels as inhabitants were encouraged to stay at home and businesses were closed. However, for the scientists this was a busy night. They conducted several measurements of skyglow and took numerous pictures including from planes flying over the city.

One of the key findings was that Brno did by far not turn into a dark place; on the contrary, the results of the sky glow measurements suggest that the contribution of public light to the overall light pollution was not major. A considerable amount of light pollution (more than half) was caused by private sources of light - advertisements, offices, parking lots, etc. – which remained switched on. The key take-away from the experiment can thus be a map of the city where the major sources of light pollution are clearly visible thanks to the comparison of public lights on and off, that will serve for directing the city administration towards regulating these sources.

Fig. 68: Brno seen from the Observatory with public lights switched on (left) and off (right)

Source: Pavel Gabzdyl/ Hvězdárna a planetárium Brno