

Regulating Light Pollution in Europe

Legal Challenges and Ways Forward

Martin Morgan-Taylor

Introduction

Light pollution raises important regulatory issues based on risks to human health and risks of ecological and environmental harm. Questions arise as to whether it should be regulated, and, if so, how. There has been recent regulation across the world. European examples include Slovenia, France, a number of Italian regions and the UK. There are also initiatives pertaining to lighting at the European level, such as the EU Eco Design of Energy Using Products Directives, a review of LED street lighting and a Council of Europe Resolution based on human rights and the environment.

The purpose of this chapter is to show that the effective regulation of light pollution requires a complete understanding of the problem, and a strategy specifically designed to address the whole problem. This chapter will first outline the main problems warranting regulation, and a legal definition for light pollution will be suggested. Secondly, the arguments for and against the regulation of artificial lighting will be evaluated. Thirdly, the different forms of legal regulation in Europe will be explored by way of case studies (taking France, Italy and the UK), and the key elements of best practice for guidance will be presented. This chapter will exclusively address external and not internal artificial lighting at night.

The Nature and Impact of Light Pollution

In order to be recognised by regulators, light pollution must have a clear and accepted definition. For this purpose, the full nature of the problems caused by light pollution will first be outlined.

Causes, Forms and Sources of Light Pollution

Light pollution results from lighting above the level required for the task (over lighting), or by inappropriate lighting practices; namely,

- by lighting when not needed (for example by lighting a car park after it has closed);
- by insufficient control where lighting shines where it is not intended (such as by light shining through bedroom windows/into the night sky);

6241-0568-PII-009.indd 159

8/27/2014 2:12:54 PM

160

Martin Morgan-Taylor

- by using inappropriate spectral types of light, which may disturb ecological or human circadian rhythms (leading to possible health problems).

These **causes** produce different **forms** of light pollution: sky glow, glare, light intrusion and the over-brightness of buildings. *Sky glow* describes the discolouration or “glow” seen over towns and cities at night, caused by light escaping or reflected upwards that is refracted by particulates in the atmosphere. The main symptom is the loss of the view of the night sky. *Disability glare* (or dazzle) is where light causes a reduction in visibility through a reduction in contrast. *Light intrusion* is unwanted light, such as light shining through a bedroom window at night. *Over-brightness* of buildings or signage occurs when building façades or illuminated signs appear contextually over-illuminated. “Light trespass” is sometimes described in the litera-

ture as stray light going where it is not wanted, such as into bedroom windows. However, its inclusion may confuse regulators because *trespass* is a legal term in common law jurisdictions (e.g. the UK and the United States), and there is as yet no court case where such a claim has been successful.

The Effects of Light Pollution

All of the effects of light pollution that may warrant regulation must be included within any definition used for the regulation of light pollution. These include the effects on safety; human health; carbon emissions; ecology; and the natural environment, including the night sky.

Safety

Artificial lighting may harm safety either through disability glare or distraction. Disability glare may occur, for example, where a security light shines into motorists' eyes, cloaking objects or people. Illuminated advertising is intended to attract attention, but this may also distract the attention of motorists, and the distraction may be worse when light sources are animated.

Human Health

Artificial light may disturb sleep by shining into bedroom windows, and English courts accept sleeplessness as a negative effect on human health (*Lewisham v. Fenner*, 1995). Research also indicates that working night shifts increases the risk of certain cancers because circadian rhythm disturbance by indoor lighting inhibits the brain's production of melatonin, a powerful antioxidant. This research has led the World Health Organisation to state that working a night shift is probably a carcinogen (International Agency for Research on Cancer, 2007), and the European Commission (SCENIHR, 2011) along with the American Medical Association (2012) to issue a warning and call for more research. Denmark has also compensated some female night shift workers who have contracted breast cancer (Wise, 2009). Other research indicates that there are cancer risks more generally with artificial light at night (Eismann, Lush & Sephton, 2010; Kloog et al., 2011), and exposure to day-light-type lighting at night ("blue-rich" lighting) suppresses melatonin production

Regulating Light Pollution in Europe

161

the most (Lockley, Brainard & Czeisler, 2003). This raises concerns given the ongoing programme replacing the incandescent light bulb, which emits little blue light, with blue-rich lighting types, such as LEDs or tungsten halogen.

Further research needs to clarify any risk posed by average light levels shining into bedroom windows, including exactly which **wavelengths, levels and duration** of lighting pose the greatest risks. Even so, it is submitted that sleep disturbance, which is quite well settled legally, justifies regulation in its own right.

Carbon Emissions/Economic Waste

Light pollution also raises issues of global environmental and economic concern. Wasted energy wastes money and carbon emissions, which are implicated in global warming. There is no official estimate as to the economic, ecological and financial cost of light pollution in Europe (see Pottharst & Wukovitsch in this volume). However, the figure of **23.5bn kg of carbon dioxide per annum, or 5.2bn Euros per annum** has been suggested as the direct cost of wasted light in Europe.¹ These figures compare well with the IDA's estimate that more than \$3 billion (c.€2.2bn)

is wasted annually on unnecessary outdoor lighting in the United States (personal correspondence, Bob Parks, IDA executive director).

Ecology

Light at night may cause circadian rhythm disruption of nocturnal species, which may in turn affect behaviour such as breeding and feeding, ultimately affecting numbers (Rich & Longcore, 2006).

For example, all 52 species of European bat have enjoyed international protection since 1994 under the Eurobats Agreement on the Conservation of Populations of European Bats (EEA), and disturbing bats is also a criminal offence under the laws of many EU Member States such as the UK (Wildlife and Countryside Act 1981, Sch. 5 and the Conservation (Natural Habitats) Regulations 1994, Sch. 4). Lighting can disturb bats by delaying their emergence at dusk to feed and breed, and can cause distraction or disorientation as bats may abandon roosts in heavily lit areas (Bat Conservation Trust & ILP, 2008), and they may be adversely affected by street lighting (Berthoussen & Altringham, 2012; Stone, Jones & Harris, 2009).

Lighting might also disturb nocturnal bird behaviour. For example, many birds annually migrating across the North Sea may die because of the distraction of oil and gas platform lighting (Poot et al., 2008). Insect numbers may similarly be reduced, and with them food for other affected animals, which are needed for pollination (Rich & Longcore, 2006; RCEP, 2009, chapter 4).

The negative effects on wildlife are expected to worsen with the increase of blue-rich LED lighting, as this light also seems to disturb animal circadian rhythms.

The Night Sky

The loss of the view of the night sky is clearly an aesthetic loss and a loss to astronomy, but the loss runs deeper still; for the loss of the view of the rest of the universe is also a cultural loss recognised by UNESCO's Starlight Initiative (2007). This

Martin Morgan-Taylor

is especially so at sites where the night sky is culturally significant, for example at Stonehenge. Are we losing our identity and perspective of the universe?

Although largely caused by sky glow (ILP, 2007), the view of the night sky may also be affected by direct glare. It is accepted that street lighting and commercial and sports floodlighting are the main causes. Research indicates that newer blue-rich LED street lighting may cause three times the sky glow of older lighting types (Luginbuhl, Walker & Wainscoat, 2009).

A Legal Definition of Light Pollution

A legal definition of light pollution is essential for effective regulation. It must be accepted and understood by all involved with light pollution (legislators, enforcers, business, scientists, lighting designers and manufacturers, objectors to planning schemes and the general public). The expression *light pollution* is taken to refer to the broad range of negative effects that may be caused by artificial lighting at night. It is therefore an interdisciplinary problem that has led to the formulation of different discipline-specific definitions, which may create problems for regulation. To further confuse the issue, the term *obtrusive light* is also commonly used, sometimes interchangeably and sometimes as a separate issue. A review of the literature does

not produce a single definition encompassing the full spectrum of problems without creating some form of ambiguity.

The European Union provides the following definition of light pollution (EU Commission Regulation No 245/2009, Annex II 3(e) and (f)):

“‘Light pollution’ means the sum of all adverse impacts of artificial light on the environment, including the impact of obtrusive light,” and

“‘Obtrusive light’ means the part of the light from a lighting installation that does not serve the purpose for which the installation was designed. . . .

[S]ky glow . . . is the brightening of the night sky that results from the direct and indirect reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gas molecules, aerosols and particulate matter) in the direction of observation.”

This may cause confusion, as *obtrusive light* and *light pollution* are defined differently, and the impact on human health is omitted from the list of effects (despite it being the effect most likely to concern the public and be used to justify regulation). A much better definition has been given by the International Dark-Sky Association (IDA), which defines it as “(A)ny adverse effect of manmade light, including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste” (IDA, 2014). This definition has much to commend it. However, it references “light trespass,” which, although often cited in the non-legal literature, is not a concept as yet recognised in common law jurisdictions (e.g. the United States and England). Also, it does not reference “obtrusive light,” which may lead to confusion. In providing a list it may lead to the exclusion of non-included problems, such as the negative effects on human health. Indeed, not including human health in

Regulating Light Pollution in Europe

163

such a list may lead legislators or enforcers to believe that human health problems are not an issue.

A definition can either outline the key issues in as few words as possible, or it can be detailed, attempting to expressly mention all of the problems caused. The author suggests the former approach where: **Light pollution or obtrusive light is any adverse effect caused by artificial lighting.** It is submitted that this definition is less open to challenge, confusion or controversy than the others as it covers the full negative impact of light pollution: The effects on safety; human health; carbon emissions; ecology; and the natural environment (including the night sky) will be covered subject to proof such as that given earlier in this chapter and elsewhere in this work. In avoiding listing what light pollution is considered to be, it avoids the potential preclusion of problems not expressly listed (including as yet unknown problems). It also reduces confusion by expressly stating that “obtrusive light” and “light pollution” are the same.

There is another challenge facing light pollution regulation, and that is how to quantify it. Recital 9 of the regulation implementing the Eco Design of Energy Using Products (EuP) Directive (EU Commission Regulation No 245/2009) references this (in a disparaging way):

In the absence of internationally agreed scientific methods for measuring its environmental impact, the significance of **the so-called** “light pollution” could not be assessed.

There is no single set of metrics because such a set will not meet the needs of all forms of light pollution. It is submitted that light pollution can be quantified in one of two broad ways; firstly, by measuring the emission of light, or secondly by measuring the negative impact that the light has. For example, some scientists want to quantify upwardly escaping light that creates sky glow and blocks out the view of the night-time sky, and there is ongoing debate as to how this is best done. This is, for example, an important factor in designing rural trunk road lighting. Other disciplines may quantify light pollution by assessing the negative impact on ecology, the human health effects of sleep or circadian rhythm disruption or the impact of glare. We know what sort of problems artificial lighting can cause, and we can measure light levels, but ideally we need international agreement on the quanta for each negative effect. Legislation may then allow for fair limits so as to clearly balance the legitimate needs of light against the environmental and social problems of light pollution; in other words, to define limits and not minimum levels of lighting.

The Arguments For and Against Regulating Light Pollution

The competing interests between whether or not to regulate artificial lighting will now be discussed. The arguments against are often based on the benefits associated with artificial lighting. This will balance the perceived needs for light at night against the problems that it may cause.

Security and Safety

The biggest arguments used against the regulation of artificial light at night are **security** and **safety**. The public believes that domestic floodlighting has a high security value by deterring burglars, hence the expression *security lighting* is almost universally used, and the expression *good lighting* is considered synonymous with high levels of lighting.

However, this argument may be exaggerated. No study indicates that domestic security lighting deters burglars and most domestic burglaries happen during the day, when artificial lighting cannot be a factor. A UK Home Office review (Farrington & Welsh, 2002) of crime reduction and lighting data concluded that there was some benefit from street lighting in some areas, but these claims are disputed. For example, Marchant has challenged this evidence, arguing that there is no clear evidence of crime reduction in the 32 London local authorities subject to the study (Marchant, 2004, 2005). It might also be argued that whilst lighting facilitates the detection of an approaching assailant, it may equally aid assailants in choosing their victims, or properties to burglarise.

Security lighting reduces the fear of crime, rather than actually reducing crime itself. However, floodlighting does provide an opportunity for passive surveillance, by illuminating the criminal. However, this advantage is often cancelled out by glare from over-bright lighting that is angled away from the householder's property into the eyes of passers-by. Therefore such lighting may do more to conceal, rather than reveal a criminal. It may also shine into the eyes of road users, harming safety, or into bedroom windows, disturbing sleep. The UK Department for Environment, Food and Rural Affairs (DEFRA) has published a joint guidance note on the correct instal-

lation of domestic floodlighting for this very reason (DEFRA, 2013a). It is submitted that the security argument is exaggerated, and it fails to acknowledge that regulation would aim to improve the effectiveness of lighting, to aid safety and security rather than switch off all of the lights.

The second major argument against regulating artificial lighting at night is that road lighting is said to aid **safety**. Again, the benefits may not be as great as thought. Although some studies (e.g. Plainis, Murray & Pallikaris, 2006), and especially early studies, have suggested street lighting makes a major contribution to road safety (reducing accidents by 30%), later research indicates this may not be as great today (reducing accidents by 10%). Ongoing vehicle safety improvements in vehicle lighting, braking, speed limiters and road surfaces may all reduce the benefits of lighting trunk roads. The statistics indicate that less light is now needed on motorways (RCEP, 2009, paragraph 3.2, note iv). Many standards for motorway lighting now state that the highest levels of lighting should be reserved for those areas where pedestrians and vehicles meet, rather than the whole road, for example European Standard 13201, street lighting (part two).

The Economy and Leisure

Harm to business through unnecessary regulation may be cited as another reason against the regulation of artificial lighting, for commercial advertising is used to draw

Regulating Light Pollution in Europe

165

people into areas at night for leisure opportunities. Hence regulation could be seen as harmful for market development, leisure and civic pride, especially during a recession.

Many European cities are attempting to boost local trade and pride by tying in major street lighting replacement programmes (and other artificial lighting-related schemes) with urban re-development. So historic and civic buildings, statues and even trees may be illuminated. Businesses may employ illuminated signs, floodlit façades, illuminated billboards or sky-beams for advertising. A European example is provided by the famous autumn Blackpool Illuminations, run since 1879, to boost the low season at a seaside resort in north-western England with an estimated 4 million visitors in 2013 (Parkinson, 2014). Cardio-vascular sports have established health benefits, and illumination allows play during the short winter days in North European latitudes. This can help meet government health objectives, boost team pride and encourage future generations of sportspeople. It may also boost sport-related business and provide jobs.

However, regulation need not adversely affect these benefits. Some of the lighting fails to meet its commercial objectives, in particular advertising or car park lighting that is on after the premises have closed and customers are in bed. However, such lighting may cause any or all of the negative effects of light pollution. Here the balance between the competing interests could be struck by switching off advertising lighting at a curfew time, or by dimming it to the (much lower) level of lighting sufficient for security.

Even in the case of lighting required during business hours, the problems caused by area floodlighting can be reduced by following good lighting practice: lighting where needed, when needed and at a level that is needed. Special asymmetric lights, designed to throw light forwards and downwards, are designed to illuminate large areas without being tilted upwards. This means that correctly fitted, suitable lighting must no longer emit light above the horizontal into bedroom windows or the night sky, while still providing the levels of light usually employed in large area lighting such as sports facilities, car parks or loading bays. Even without such

asymmetric lighting, a cure may sometimes be possible by angling existing lighting downwards to the horizontal, using shields to cut stray light, not over lighting (see later in this chapter), or again by the use of curfews.

These approaches clearly cannot be used for illuminated signs, where the aim is often to engage in competitive lighting (light wars). However, a solution here (which is applicable to lighting generally) is simply to prevent over-lighting; to light to, and not above, the level of light deemed acceptable for advertising. There are emerging models for industry self-regulation that prescribe maximum levels for illuminated billboards and other advertising lights (e.g. ILP, 2005).

Sky-beams present a special problem, as they are intended to attract attention and the methods for controlling light discussed earlier are not suitable. Sky-beams can be a serious problem: By attracting attention they may distract motorists, dazzle or confuse airline pilots, block out the night sky or disturb ecology. Here then the balance of social use and negative effects could be set with regulation based on one of the main arguments used against regulating artificial lighting, namely safety.

Similarly, some sports facilities over light, or use unshielded lights offering poor light spill control. It is accepted that (inter-)national-level facilities need higher

lighting levels, and it is said that higher lighting levels are needed for high-definition broadcasting, but camera sensitivity is steadily improving. Moreover, these larger facilities should have the resources to afford a lighting scheme design which will control the lighting used, such as the asymmetric designs discussed earlier that are designed to throw their light forwards without being tilted above the horizontal.

However, lighting at small facilities, which are often sited close to roads or residential areas, may not be professionally planned, or of a suitable type designed to illuminate a large area whilst minimising light pollution. It tends to be cheaper to buy lighting without the benefit of shielding from stadia or vegetation. This leads to (avoidable) glare, wasted energy/carbon emissions and potential negative health effects for local residents or the local ecology. Hence regulation could effectively balance the legitimate use of light against the problems that it may cause.

Again, regulation would serve to foster good lighting, striking the balance between the social utility of the sports facility and the negative impact that the light may have: The right amount of light, of the right type, where needed, when needed. This would avoid over lighting, use the correct type of lighting, which has been fitted or shielded correctly, which is on only when needed. It is clear, then, that the negative impacts of light pollution may be reduced without detracting from the economic or social advantages that artificial light may offer: Light pollution is not an unavoidable consequence of economic or social development.

It must also be noted that regulation may offer remote areas economic and leisure benefits. For example, the International Dark-Sky Association grants "Dark-Sky" status to places that aim to protect and restore the quality of the night sky. The Starlight Foundation has a similar "Starlight Reserve" concept. The clear opportunity for leisure that can aid the local economy is "dark-sky tourism." As the night sky is usually best seen during the winter months, this should boost off-season trade (see Meier in this volume). Some countries such as Wales and Scotland are even considering dark sky country status to boost trade and preserve the environment.

Legal Regulation Within Europe

The mechanisms that may be used for regulation will now be addressed, followed by an examination of some of the different types of regulation employed in Europe. Regulation can take a number of forms: It may seek to address only one aspect of the light pollution problem (e.g. energy waste under environmental regulation), or it may take a holistic approach attempting to tackle the entire problem. Regulation may take the form of formal law, or soft law in the form of guidance. This guidance may come from local or national governments or from the lighting industry in conjunction with other interest groups that have an ecological or astronomical background. Light pollution may be regulated at the national level by using the bolt-on approach, such as the statutory nuisance or planning regime in England, which addresses some (but not all) of the problems caused by light at night using pre-existing regulation. Or it may be addressed with specific bespoke legislation, as is the case in France, Italy and Slovenia. These latter regimes serve as good examples for balancing the competing interests, based on a clear understanding of the problem. Regulation may also be made at a regional level, including EU action, or via the

Regulating Light Pollution in Europe

167

Council of Europe (which has looked at the human rights aspects of light pollution), or at national or more local levels.

National or Regional Regulation in Europe

Using England and Wales, France, Italy and Slovenia as examples, these different forms of regulation in Europe will now be discussed.

England and Wales

Regulation in England and Wales is bolted into other regulatory goals, for example planning legislation (English National Planning Policy Framework, 2012, paragraph 175). However, it is only partially caught because of requirements of the pre-existing law. For example, English planning law limits the consideration of exterior lighting to cases where there is an impact on the daytime visibility of the light fittings. This is because the cases really concern the **light fittings**, rather than any problems caused by the **lighting**. So, in *Kensington and Chelsea Borough Council v. CG Hotels and Another* (1981), it was argued successfully that the installation of floodlights did not constitute development, as they were practically invisible during daylight hours. Thus, compact but very bright wall-mounted LED floodlighting may not be prominent during daytime hours; and so it may be less likely to be viewed as a “development” requiring planning permission under English law. However, as shown earlier, night-time floodlighting is a key cause of light pollution.

Another example where floodlighting may escape English planning regulation is where the floodlighting is inset within the ground to provide upward illumination of the façade of a building at a glancing angle. Here the impact on daytime visibility may again be minimal, so that there may be no “development” attracting planning control. Yet there may be a serious night-time light pollution problem because, by the very nature of inset floodlighting, it will be pointing directly upwards, and is very difficult to shield.

Subject to these restrictions, the central government has long made it clear that light pollution should be considered at the planning stage. To this end, it has recently published a short guidance note on what this means in practice, entitled “When Is Light Pollution Relevant to Planning”? (DEFRA, 2013b). This is very welcome as it addresses the current mixed and inconsistent response from planning authorities to light pollution. This is supplemented by other guidance from the lighting industry

in association with other stakeholders, such as astronomical and ecological bodies. The UK Institution of Lighting Professionals regularly updates its “Guidance Notes for the Reduction of Obtrusive Light” (with the latest being GN01:2011).

The English statutory nuisance legislation offers another bolt-on approach. In order for it to apply, there must be an act or omission that is either “prejudicial to health” or is otherwise a “nuisance” (Clean Neighbourhoods and Environment Act 2005). The “human health” limb may cover cases where lighting causes loss of sleep by shining into bedroom windows. Clearly it will also cover any of the cancer-related health effects that were discussed earlier, if these are ultimately proven to be caused by light pollution.

Martin Morgan-Taylor

The “nuisance” limb covers disturbance of personal comfort that does not have a direct effect on human health. (*Malton Board of Health v Malton Manure Co*, 1879; *Salford CC v McNally*, 1976; *Godfrey v Conwy BC*, 2001). These criteria have been met in several UK **private nuisance**² cases involving lighting, where car park (England: *Bonwick v Brighton Hove*) and sports facility lighting (Wales: *Bacon v Gwynedd CC Tywyn*, 2004) have been shining into property windows and where night fishing has been disturbed by adjacent sports facility lighting (Scotland: *Stonehaven and District Angling Association v Stonehaven Tennis Club*, 1997). It must be noted that some protection is possible for occupiers of property, not only from light that affects their health or reasonable enjoyment, but also in theory against light that affects some of the more aesthetic aspects of the enjoyment of property.

A problem is that nuisance is based on the protection of the human enjoyment of property or health, whilst light pollution is a wider environmental issue. So whilst nuisance may apply to light pollution that unreasonably interferes with sleeping, night fishing and so forth, it cannot protect against the wider aspects of light pollution, namely, wasted carbon emissions, ecological damage and damage to the night sky, unless they meet the criteria of affecting property interests or harming health.

What constitutes property enjoyment in nuisance is construed narrowly. The English test requires:

an inconvenience materially interfering with the ordinary comfort physically of human existence, not merely according to elegant and dainty modes of living, but according to plain and sober and simple notions. . . .

(*Per Knight-Bruce V.C. Walter v. Selfe* (1851) at 322)

Even where statutory nuisance does cover light pollution, its utility is severely restricted by the long list of exempt premises under section 79(5B) of the 1990 Environmental Protection Act. There seems no good reason for making these premises exempt as the defence of “best practical means” applies under section 79(9) of the same act, so as to balance the competing interests of social utility against harm. This should protect the legitimate use of light without arbitrary outright exemptions. Consequently, the nuisance regime, by its nature, can only offer assistance to a limited range of problems caused by light pollution.

France

France offers perhaps the best example of a bespoke environmental law (Arrêté du 25 janvier 2013). Emerging from the French amateur astronomical community, it recognises the wider spectrum of problems caused by light pollution. The law

is a result of the Grenelle Environnement Round Table meeting, which followed a call from the French astronomical community to legislate against the loss of the night sky, the disruption of nocturnal animal life and wasted energy. The Association Nationale pour la Protection du Ciel et de l'Environnement Nocturnes (ANPCEN) has provided supplementary guidance to the law on environmentally friendly lighting design, which shows how local authorities and communities can balance the competing interests, namely, a reduction of light pollution without a concomitant

Regulating Light Pollution in Europe

169

reduction in safety or security. To this end it released the Charter for the Protection of the Sky and Nocturnal Environment (*Charte de Protection du Ciel et de l'Environnement Nocturnes*), in association with other astronomical bodies.

The French light pollution law addresses light pollution on several fronts, using both hard law and supplementary guidance. It aims to reduce business energy bills by cutting waste, which is especially relevant during the current recession, but it also aims to tackle the wider broad spectrum of problems light pollution causes from all non-residential premises, including shops. From 1 July 2013, interior lights in business offices and other non-residential buildings, including lights in shop windows, must be switched off an hour after the last worker has left (article 2). In addition, the law will require non-residential buildings to switch off their exterior lighting (and shop window displays) between 1 a.m. and 7 a.m., when almost all businesses are closed (articles 2 & 3).

However, some lighting is exempt from the French law. In particular, some types of business premises are said to require high levels of light for security reasons. As shown earlier, lighting is generally accepted by the public and business at face value as aiding security. Indeed, this "need" argument is similar to that used to justify the premises that are exempt under the English/Welsh statutory nuisance law, and marks a potential weakness. Education on good lighting practices is critical to ensure that this does not become a loophole used to circumvent the legislation. A lack of understanding could similarly be used as a vehicle for attempts by business to repeal the law as harmful to the legitimate security needs of business based on a misunderstanding of the issues.

The exemption for commercial floodlighting which is activated by sensors is probably a fair compromise, and it is more likely to be accepted by business and the public, as psychologically it does not ban lighting completely. Instead, it requires lighting to be on sensors, which cannot harm security concerns. The author hopes that the law can be extended to ensure that such lighting is also installed correctly (that is, angled correctly to avoid glare etc.).

Local authorities are permitted to exempt Christmas lighting or the lighting of "exceptional events of a local nature," including illuminated displays in "exceptionally busy" tourist areas (article 4). Again, these offer an effective compromise, so that national cultural symbols (and tourist attractions) such as the iconic Eiffel Tower remain illuminated, but other "lesser" buildings not meeting these criteria will not, so long as the exemption is not abused. There is a potential danger in the way that the exemption for tourist purposes is calculated; this judgement will need to be made using a full consideration of the benefits and detriments that the lighting offers. This might be problematic in practice.

Italian Regions and Slovenia

The approach in Italy, like in France, is founded on consideration of the wider aspects of light pollution, via bespoke laws. In 2000, the region of Lombardy made

it illegal to install most luminaires emitting light directly above the horizontal. The law limits all installations to 0.49 candelas/km at 90° (horizontal), with an exception for luminaires under 2,250 lumens.³ This lower limit permits the use of light sources

Martin Morgan-Taylor

that emit heavily above the horizontal (e.g. globe lights), if the total lumen output is less than 2,250 (Law of the Lombardy Region no. 17 of 03/27/2000). The regime is enforced at the municipal level, and places obligations on users, manufacturers, designers and installers (section 2).

Similar legislation is now in place in 15 of Italy's 20 regions (including Emilia-Romagna, Umbria, Puglia, Friuli Venezia Giulia and Marche). Again, the Italian laws are drafted to address a broad range of problems caused by light pollution, by controlling the emission of light above the horizontal, and so are not limited to one or two aspects such as nuisance or human health.

Slovenia adopted a similar bespoke law in 2007, requiring "fully shielded" lighting, which, in most instances, prevents light output above the horizontal (Government Regulation 4162). Again, this law addresses the light pollution problem directly. The law is based on a broad understanding of the problem, such as cutting the energy use of public lighting, such as street lighting and historic buildings, human and ecological health, glare and the loss of the night sky. Like in other jurisdictions with lighting laws there are exceptions, such as for festivities and decorative lighting 1 December–1 January, military, rescue operations and some cultural areas. It is forbidden to illuminate roost entrances used by flying animals such as bats, which will help ecology. There is also an expectation that historic buildings will be illuminated from above, and where this is not possible no more than 10 per cent of the light should escape from the façade. Sky-beams are totally forbidden.

Comparison and Assessment

Out of all the legislative variations, the French regulation probably offers the widest coverage of all the aforementioned examples. The Italian and Slovenian laws focus specifically on the issue of light escaping above the horizontal. However, the French model goes even further with the imposition of a blanket curfew for non-residential lighting.

The approaches in France, Italy and Slovenia are more effective models than that of the UK for regulating an environmental problem such as light pollution. This is because they are based on the broad understanding of the totality of the problems caused by light pollution. This is in contrast to the UK approach, which relies on bolting on limited aspects of the light pollution problem into pre-existing legislation.

Truly holistic regulation requires that light pollution is considered at the design and build stages, particularly so as to ensure that off the shelf lighting is designed with consideration being given to the levels of lighting, the colour spectra, light spill controls, whether it is impossible to install the light fitting so as to avoid upwardly escaping light and fitting instructions. However, none of the national laws described earlier attempts to address light pollution at these stages. Such an approach could avoid a lot of problem lighting being installed in the first place, and reduce the regulatory burden of addressing it retrospectively once it has been fitted. Such consideration could, for example, avoid the mistake of the 500w tungsten-halogen floodlight commonly used as domestic security lighting, which is over powered, and

has no effective light spill controls; it is impossible to fit many of these types so as to avoid upwardly escaping light.

Regulating Light Pollution in Europe

171

Pan-European Regulation

The limited European Union involvement in light pollution has been based on energy consumption. For example, the EuP Directive 2005 is currently a most relevant EU regulation affecting outdoor lighting. It considers the total energy footprint of a product, from design to disposal. This imposes obligations on manufacturers of lights to promote good designs and to discontinue less efficient types.

However, the EuP Directive is probably an opportunity lost for the regulation of light pollution across the EU. Firstly, the Directive is only based on energy waste, which is, as stated earlier, only one aspect of light pollution. Secondly, the Directive only addresses some lighting types, whilst light pollution may result from any exterior lighting. There are still no EU plans to regulate light pollution per se, or lighting more generally. Ironically, such regulation could control the energy waste of the 500-watt domestic security light commonly subject to complaint. Lighting manufacturers may be more likely to develop luminaires that cause less light pollution because of demand from the financial constraints of their clients.

LED technology represents the next generation of lighting, and offers greater energy efficiency; “blue-rich” LED lighting being the most efficient, does, however, raise concerns for human and animal health. The EU’s green paper “Lighting the Future” (European Commission, 2011), which considers the impact of LED technology in cities, focuses on energy efficiency and remains silent on these other concerns.

The wider health and environmental concerns posed by blue-rich lighting are serious enough to consider the application of the European Precautionary Principle of environmental risk. The principle, which places the burden of proof that the action is **not** harmful on the action taker, applies “(w)here scientific information is insufficient, inconclusive, or uncertain and where there are indications that the possible effects on the environment, or human, animal or plant health may be potentially dangerous and inconsistent with the chosen level of protection” (European Union, 2000, para. 1). If applied to artificial light, then blue-rich lighting might be considered unsafe unless it could be proven that the harm to health and the environment is less than that indicated by the existing research.

A wider approach to light pollution has been taken by the Council of Europe (CoE), which has a far greater remit than the EU, based not just on economic considerations, but on democracy, human rights, health and culture. Further, the CoE has a greater geographical influence with 47 members to the EU’s 28, but CoE resolutions are not binding on member states. The CoE has called for a comprehensive package of action based on human rights in its Noise and Light Pollution Resolution (CoE, 2010), which is based on a wider understanding of the problem. The resolution, which encourages research, calls for the mapping of light pollution regionally and nationally from permanent observatories; disseminating this data so as to better educate and inform decision makers; adding light pollution to national school curricula and public education more generally; involving scientists, including astronomers and environmentalists, in determining maximum appropriate lighting levels for roads and the proper maintenance of the night sky; and controlling light spillage from all properties. Further, the CoE has recommended that nations be

invited to review their legislation with respect to light pollution, and to consider whether pan-European measures are necessary (CoE, 2010, A. 8 generally and 9.8, Draft Resolution and B. 2.1 and 2.2).

Education and Guidance

Regulation can only be effective when it is based on a full understanding of the problem, and this calls for effective research and education, as is recommended by the CoE initiative. It is submitted that the CoE approach offers the most holistic approach to education of all of those examined. Better education is crucial to changing political, business and consumer expectations, that is, the regulators and users of lighting, so that they are based on fact and not on misunderstanding. Such education could help to ensure that both regulators and users of artificial lighting understand why regulation is needed; that is, to understand the need for lighting with “the right amount of light, of the right type, where needed, when needed,” and that it is not about switching off all of the lights. An understanding that light pollution can be reduced without affecting the benefits of lighting could reduce the general wish to over light. Education on the broad impact of light pollution could, in fact, lead to spontaneous calls for the introduction of effective regulation by the public in the interest of, for example, their own health, and responsible spending of public money.

However, success here requires that the bodies responsible for education themselves fully understand the issue, especially those parties that can influence compliance, in either an advisory or regulatory capacity. There is an issue of how these bodies educate the public in general. The UK's Energy Saving Trust, which offers guidance and information on ways to save energy and cut carbon emissions, may be expected to offer exterior lighting advice. Whilst it advises on interior lighting, it does not offer advice regarding exterior lighting (other than putting lighting on PIR motion sensors).

The lack of understanding may be compounded where a body relies on guidance from another organisation. For example, planning authorities are increasingly requiring planning applicants to present energy-efficient designs. Consequently, applicants may seek certification from bodies such as BRE Environmental Assessment Method (BREEAM) to the effect that what is proposed meets good standards of environmental design, construction and management. However, **exterior** lighting is again often not considered by these certification bodies. As a result, planners may unintentionally grant planning permission for unsuitable lighting. This problem underscores the need to educate certification bodies so that their schemes include good lighting design to minimise light pollution.

Furthermore, enforcement bodies must become knowledgeable about the key issues of what light pollution is and what should be done about it. This need is urgent given the reluctance of some enforcement bodies to treat the matter seriously. For example, the burden of abatement is often put on the victim, by telling them to fit thicker curtains.

Finally, lighting manufacturers also need a full understanding of light pollution at the product design stage. Clearly many of the decisions affecting light pollution are

made at this stage, for example concerning the spectral type or power of the light source, or fittings that are impossible to install so as to avoid upwardly escaping light. Good design can help to reduce light pollution in the first place. Indeed, this is where the educational issue comes full circle, for manufacturers will only change designs if they are required to do so by regulation or demand from purchasers, and, as shown, both of these influences are dependent on education. Regulation will only come where there is a perceived need, and this will only come from a full understanding of the key issues.

Conclusion: A Truly Holistic Approach

It has been shown that there are several challenges for effective regulation of light pollution. There must be a single definition for light pollution that is understood and accepted by all interested parties, namely, legislators, enforcers, industry and consumers. The definition must encompass the full spectrum of problems caused by light pollution and avoid confusion between “obtrusive light” and “light pollution.” It is suggested that **light pollution or obtrusive light is any adverse effect caused by artificial lighting**. Regulation must also be based on an understanding of the entire problem; that light pollution is not just concerned with the loss of the night sky, but is a complex and emerging problem including human health and ecological and environmental harm, of which the loss of the night sky is part. The prerequisite for this is an understanding of and a commitment to continue with research.

Without this broad understanding, calls for regulation may fail because of misconceptions that light pollution is not serious enough to warrant regulation, or that a balance cannot be struck without unreasonably harming safety, security and economic interests. France illustrates that the most robust laws are rooted in a full understanding of the issues; it balances the wider concerns of energy waste and environmental or cultural harm with the social and economic benefits of artificial lighting. Therefore, the French law addresses the types of lighting and lighting practices that may cause light pollution. For example, limiting lighting levels to and not over a set standard (to cut over-lighting), or by imposing a curfew on lighting types (such as when commercial premises are closed) and controlling light spill. In effect, it regulates towards having light where needed, when needed, at a level that is needed.

Regulation by “hard” law is not the whole story, for effective light pollution control is best supported by other means. Guidance is of particular importance and can come from supra-national bodies such as the CoE, national or local authorities, or from industry and/or stakeholder groups (such as France’s Charter for the Protection of the Sky and Nocturnal Environment). The latter offers an excellent opportunity to engage with lighting professionals towards a better understanding of the key issues and what can realistically be done about them.

Further, effective light pollution control requires general education of the public, commerce, regulators and enforcement bodies, which may help to shift public and commercial attitudes to artificial lighting at night from myth to evidence-based fact. For example, changing attitudes should lead to changing purchasing habits, and

may augment calls for and the understanding of lighting control. Education must break down preconceptions such as “the brighter the better,” or that lighting is needed all of the time and that any form of lighting control is an unjustifiable fetter on personal autonomy, safety and security: replacing these attitudes with an understanding of the right amount of light, of the right type, where

needed, when needed. Education should also lead to light pollution being taken more seriously by enforcement bodies: Any law is worthless without adequate enforcement.

The road to effective regulation is likely to remain a lengthy one, but the CoE initiative offers the hope that with research and education the need for effective regulation will be appreciated and accepted. France currently leads the way because of its broad coverage, the use of supplementary guidance and the use of curfews. It is hoped that other countries will follow suit.

Notes

- These figures assume that the EU has 700 million citizens and spends on average 90 kWh per person per year for public lighting and another 27 kWh per person on private outdoor lighting (commercial parking, domestic lighting and billboards). It is believed the actual needs are 50 kWh/person (40 kWh for public lighting and another 10 kWh for private lighting). So the wasted energy per person is 67 kWh (117 kWh – 50 kWh = 67 kWh). Whilst the waste carbon per person is c.33.5kg (1 kWh creates 0.5 kg CO₂ or c.33.5 kg CO₂ for 67 kWh). The average price per kWh in the EU is c.€0.11. Therefore the waste per EU citizen is €0.11 × 67.5 kWh = €7.4. **With the total energy wastage in the EU being 700M ×**

7.4 = €5.2bn per annum, and the CO₂ waste 700M × 33.5 kg = 23.5Bn kg CO₂ per annum.

- Here, the individual takes the action, and the test is broadly the same as with statutory nuisance.
- A lumen (lm) is the total “amount” of light emitted by a source. The candela (cd) is a measure of “luminous intensity,” or the amount of light given off by a source in a particular direction.

References

- American Medical Association (AMA). (2012, June 21). *Light Pollution: Adverse Health Effects of Nighttime Lighting*. Report 4 of the Council on Science and Public Health (A-12). Chicago, IL: American Medical Association.
- Arrêté du 25 janvier 2013 relatif à l'éclairage nocturne des bâtiments non résidentiels afin de limiter les nuisances lumineuses et les consommations d'énergie. France.
- Bacon v. Gwynedd CC Tywyn*, unreported, case no. AB 300050 (2004).
- Bat Conservation Trust & UK Institute of Lighting Professionals (2008). *Bats and Lighting in the UK*. Bats and Built Environment Series. London & Rugby.
- Berthinussen & Altringham (2012). The Effect of a Major Road on Bat Activity and Diversity. *Journal of Applied Ecology*, 49(1), 82–89.
- Bonwick v. Brighton Hove*, England (unreported), County Court Claim: BN 906 721 (2000). Clean Neighbourhoods and Environment Act 2005, s. 102.
- Council of Europe (2010). *Resolution 1776 Noise and Light Pollution*. Adopting Doc. 12179, 22 March 2010, Noise and light pollution report, Committee on the Environment, Agriculture and Local and Regional Affairs.
- Department for Environment, Food and Rural Affairs (DEFRA). (2013a). *Getting Light Right*. London.
- Department for Environment, Food and Rural Affairs (DEFRA). (2013b). *When Is Light Pollution Relevant to Planning?* London.
- Eco Design of Energy Using Products (EuP) Directive 2005/32/EC(74).

6241-0568-PII-009.indd 174

8/27/2014 2:12:54 PM

Regulating Light Pollution in Europe

175

- Eismann, E. A., Lush, E. & Sephton, S. E. (2010.) Circadian Effects in Cancer-Relevant Psychoneuroendocrine and Immune Pathways. *Psychoneuroendocrinology*, 35(7), 963–976.
- English National Planning Policy Framework 2012. Department for Communities and Local Government, Her Majesty's Stationary Office.
- Environmental Protection Act 1990.
- Eurobats Secretariat. Bonn, Germany. Retrieved from [http://www.eurobats.org/EuropeanCommission,Directorate-GeneralforHealth&ConsumersScientificCommitteeonEmergingandNewlyIdentifiedHealthRisks\(SCENIHR\)\(2011\).HealthEffectsofArtificialLight](http://www.eurobats.org/EuropeanCommission,Directorate-GeneralforHealth&ConsumersScientificCommitteeonEmergingandNewlyIdentifiedHealthRisks(SCENIHR)(2011).HealthEffectsofArtificialLight).
- European Commission (2011). *Green Paper. Lighting the Future: Accelerating the Deployment of Innovative Lighting Technologies*. COM (2011) 889.
- European Union (2001). *Communication from the Commission on the Precautionary Principle*, COM (2000) 1 final.
- European Union Commission Regulation No 245/2009, implementing Directive 2005/32/EC.
- Farrington, D. P. & Welsh, B. C. (2002). *Effects of Improved Street Lighting on Crime: A Systematic Review*. HORS 251, UK Home Office Research, Development and Statistics Directorate.
- Godfrey v Conwy BC*, Env LR 38 at 23 (2001).
- International Agency for Research on Cancer (2007, December 5). *International Agency for Research on Cancer (IARC) Monographs Programme finds cancer hazards associated with shiftwork, painting and fire fighting*. Press Release 180. Lyon: IARC.
- International Dark-Sky Association (2014). *Light Pollution Frequently Asked Questions*. Retrieved from <http://www.darksky.org/about-ida/faqs>
- Institute of Lighting Professionals (ILP). (2005). *Brightness of Illuminated Advertisements*, TR05. Rugby: ILP.
- Institute of Lighting Professionals (ILP). (2007). *Towards Understanding Sky Glow*. Rugby.
- Kensington and Chelsea Borough Council v. CG Hotels and Another*, JPL 190 (1981).
- Kloog, I., Portnov, B. A., Rennert H. S. & Haim, A. (2011). Does the Modern Urbanized Sleeping Habitat Pose a Breast Cancer Risk? *Chronobiology Int.*, 28(1), 76–80.
- Law of the Lombardy Region no. 17 of 03/27/2000. Urgent measures to fight the light pollution and to achieve energy saving in the use of outdoor lighting.

Lewisham v. Fennner, 248 ENDS Report 44 (1995).

Lockley, S. W., Brainard, G. C. & Czeisler, C. C. (2003). High Sensitivity of the Human Circadian Melatonin Rhythm to Resetting by Short Wavelength Light. *Journal of Clinical Endocrinology & Metabolism*, 88(9), 4502–4505.

Luginbuhl, C., Walker, C. & Wainscoat, R. (2009). Lighting and Astronomy. *Physics Today*, December 2009, 32–37.

Malton Board of Health v Malton Manure Co, 4 Ex D 302 (1879).

Marchant, P. (2004). A Demonstration that the Claim that Brighter Lighting Reduces Crime Is Unfounded, *British Journal of Criminology*, 44, 441–447.

Marchant, P. (2005). What Works? A Critical Note on the Evaluation of the Crime Reduction Initiatives, *Crime Prevention and Community Safety*, 7(2), 7–13.

Parkinson, S. (2014, February 5) Illuminations Save Blackpool's Season. *The Gazette*. Retrieved from <http://www.blackpoolgazette.co.uk/what-s-on/going-out/illuminations-save-blackpool-s-season-1-6420487>

Plainis, S., Murray, I. J. & Pallikaris, I. G. (2006). Road Traffic Casualties: Understanding the Night-time Death Toll. *Injury Prevention*, 12(2), 125–128.

Poot, H., Ens, B. J., de Vries, H., Donners, M.A.H., Wernand, M. R. & Marquenie, J. M. (2008). Green Light for Nocturnally Migrating Birds. *Ecology and Society*, 13(2), 47.

Regulation Implementing the Eco Design of Energy Using Products (EuP) Directive (EU Commission Regulation No 245/2009).

Rich, C. & Longcore, T. (Eds.). (2006). *Ecological Consequences of Artificial Night Lighting*. Washington, DC: Island Press.

Royal Commission on Environmental Pollution. (2009). *Light Pollution and the Environment*. London.

Salford CC v. McNally, A.C. 379, Lord Wilberforce at 389 (1976).

Slovenian Government Regulation 4162 on the Limits of Light Pollution of the Environment, on the basis of Article 17, paragraph 3 and 5 of the Environmental Protection Act. Official Gazette of the Republic of Slovenia, No. 39/06—official consolidated text, 49/06—Law on Meteorological Activities, 66/06—Decision of the Constitutional Court and 33/07—Spatial

Planning Act, adopted by the Government of the Republic Slovenia, Regulation About the Limits of Light Pollution on the Environment.

Stone, E. L., Jones, G. & Harris, S. (2009). Street Lighting Disturbs Commuting Bats, *Current Biology*, 19, 1–5.

Stonehaven and District Angling Association v. Stonehaven Tennis Club, unreported, Stonehaven Sheriffs Court, 1997.

UNESCO Starlight Initiative (2007). International Initiative in Defence of the Quality of the Night Sky as Mankind's Scientific, Cultural and Environmental Right. Retrieved from <http://www.starlight2007.net>

Walter v. Selfe (1851) 4 DeG & Sm 315.

Wise, J. (2009). Danish Night Shift Workers with Breast Cancer Awarded Compensation. *BMJ*, 338, b1152.