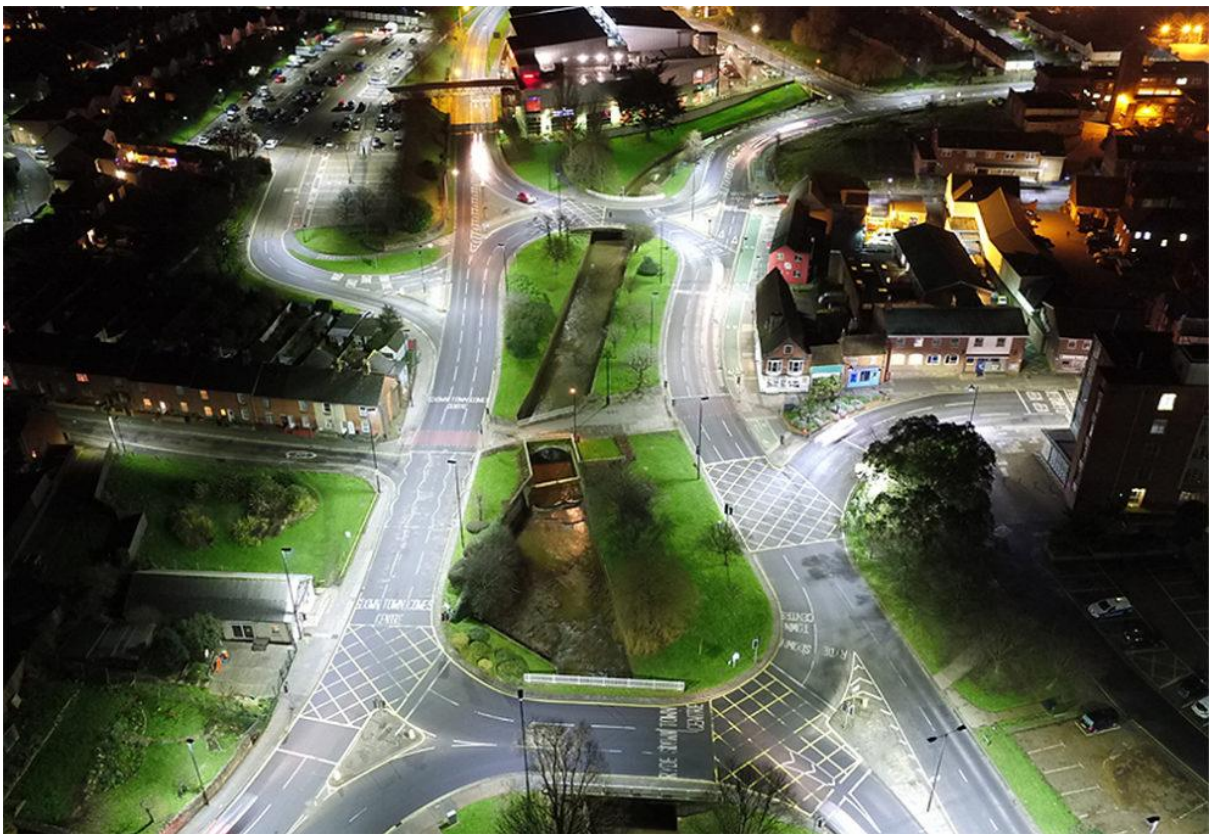


A bright idea?

Adverse health, social and environmental impacts associated with LED street lighting



About LightAware

LightAware (SC046160) is a charity which was founded in 2015 to respond to the needs of those whose lives and health have been profoundly affected by the ban on incandescent lighting and the development of new forms of light, including LED technology. LightAware's charitable objectives are:

- To raise awareness about the effects of artificial lighting on human health and wellbeing.
- To stimulate discussion and investigation into the effects of artificial lighting on human health and wellbeing.
- To promote equality and diversity through encouraging provision of access to civic life for those excluded by sensitivity to artificial lighting.

About light-sensitivity

Some people with pre-existing health issues, such as migraine and lupus find their conditions exacerbated by LED street lighting. Others with no previous health issues also experience problems including searing eye pain, debilitating headaches, skin burning and rashes, dizziness, fainting and vomiting.

For some, the symptoms are milder: anxiety, eczema, edginess or just a sensation of discomfort or 'wrongness' that is hard to locate. Senior doctors have expressed concerns about the effect of new lighting technology on human eyes, skin, circadian rhythm, and nervous system. But there are many questions still unanswered:

- How does artificial lighting affect human health and wellbeing?
- How many people are adversely affected by new forms of lighting?
- How does one type of light bulb cause different problems in different people?
- Why are some people affected by some forms of lighting and not others?

LightAware believes these questions, and many more, urgently need addressing. We seek to stimulate research and investigation into the effect of artificial lighting on human health, and to compile the information currently available.

Report cover photograph: *We would also like to thank Darren Toogood, Editor and Publisher of the Island Echo for permission to use the photograph used on the cover of the report.*

Contents

Summary	4
Key conclusions	5
Key recommendations.....	5
Introduction.....	8
Why we created this report.....	8
Why LED lighting is different to other types of lighting	9
Councils introduced LED street lighting without fully considering its impact.....	12
LED street lighting was introduced with little public consultation.....	12
Few councils undertook appropriate impact assessments before introducing LED street lighting.....	13
Most councils have not taken into account the recommendations of reviews of the health impacts of LED lighting	15
Recommendations	17
Councils are introducing LED street lighting to save money	19
Councils are spending substantial sums on LED street lighting.....	19
LED street lighting is becoming the norm across the UK	20
Problems with LED street lighting are becoming apparent, including health and safety problems	23
Recommendations	25
LED street lighting makes some people ill.....	26
High luminance can cause problems with glare.....	26
LED flicker can cause migraines and also presents a safety hazard	27
LED street lights can cause sleep disturbance	28
LED street lighting exacerbates a number of light sensitive illnesses	30
It is difficult to estimate the number of people severely affected by LED street lights, but everyone is affected to some extent.....	32
Recommendations	33
LED street lighting can have a detrimental effect on the environment.....	34
Light pollution is a major environmental issue	34
Recommendations	37
Appendix 1 Light sensitive individuals' experiences of LED street lighting	38
Appendix 2: LightAware freedom of information request.....	45

Summary

What we did

1. This report has been prepared by the charity LightAware. It examines the extent to which councils have installed LED street lighting and the measures they have taken to ensure the health and safety of residents and to minimise its environmental impact.
2. Our methodology included a Freedom of Information request sent to councils in England, Scotland and Wales, desk research and discussions with light-sensitive people about the impact LED street lighting had on their health and wellbeing.

What we found

3. Most councils introduced LED street lights without consultation or fully considering their impact on public health and the environment. Although over 97 per cent of councils have installed LED street lighting, only 30 per cent consulted their residents beforehand and less than half piloted its introduction. Only 17 per cent of councils conducted a Health Impact Assessment; 22 per cent an Environmental Impact Assessment; 32 per cent an Equality Impact Assessment and 21 per cent a Disability Impact Assessment. In many cases, councils installed blue light rich LEDs after the publication of scientific reports by the EU and health agencies warning of their adverse health and environmental impacts.
4. Over half of councils (55 per cent) use solely LEDs with a colour temperature of 4000K or above, which have the greatest negative impact on human health and the environment (Colour temperature is a way to describe the light appearance provided by a light bulb, giving people an idea of the look and feel of the light produced). Only nine councils have installed a significant number of lower colour temperature LED street lights, which have less impact on people's health and on the environment (although they still have severe adverse health impacts on some people).
5. EU Procurement Guidelines recommend that 'warm white' street lighting of 2700K and below should be installed in residential areas. Most councils ignore this guidance and continue to install cheaper to run 'blue rich' LED street lights, despite the mounting weight of scientific evidence of their more damaging impact on health and the environment.

Why this is important

6. The long-term effects of LED lighting are untested and several challenges are becoming apparent. including significant negative impacts on public health and well-being, road safety and the environment. The main health risks associated with LED-based street lighting are due to:
 - extreme brightness (high luminance) which causes glare and eye pain for some
 - flicker, which causes migraines

- a spike at the blue wavelength which disrupts circadian rhythms by suppressing the sleep hormone melatonin. This also causes adverse health impacts in some people, including those suffering from lupus and from some skin conditions. In addition a portion of the blue light spectrum has been shown to trigger migraines and cause discomfort in people with this condition. ¹

Key conclusions

- **Councils have introduced LED street lighting to achieve savings and reduce carbon emissions without taking account of its adverse health and ecological impacts. Councils did not adequately consult residents with light sensitive conditions before its introduction. LightAware believes that councils that introduce LED street lighting without proper consideration of its adverse impacts are infringing the human rights of light-sensitive people whose health and well-being is adversely affected.**
- **LightAware believes that there is a sufficient risk of people and the environment being harmed by LED street lighting to invoke the ‘precautionary principle’. This states that if an action or policy has a suspected risk of causing harm to the public, or to the environment, in the absence of scientific consensus (that the action or policy is not harmful), the burden of proof that it is not harmful falls on those taking that action.**
- **To be effective, health and environmental policies require a holistic multidisciplinary approach that considers the health, social, economic, public safety, and ecological impacts of the introduction of new technologies such as LED lighting. So far, its introduction has been driven by financial savings and carbon reduction targets without regard to its wider social, health and ecological impacts. It is time for councils to remedy this shocking state of affairs.**

Key recommendations

- **Public Health England (and its successor body the National Institute for Health Protection) should support research to find out why LED street lighting is causing ill-health and set standards for external lighting to ensure that light-sensitive people can safely leave their homes at night.**
- **Councils should introduce a moratorium on the roll out of LED street lighting and maintain current street lighting until it reaches the end of its useful life or until such time that safe replacements can be found. Councils should retain a supply of parts to help them maintain current street lighting.**

¹ Maine A, Vlachonikolis I, Dowson A. The wavelength of light causing photophobia in migraine sufferers and tension-type headache between attacks, *headache* 2000, 40, 194-199.

- **Where street lighting has come to the end of its economic life and needs to be upgraded, councils should consult communities about replacement street lighting, including:**
 - an assessment to ensure that it meets the Public Sector Equality Duty
 - undertaking Regulatory Impact Assessments covering equalities, health, disability, and the environment
 - identifying light sensitive residents and taking steps ensure they are not socially excluded, including retaining conventional street lighting in their neighbourhood
 - in rural areas, encouraging the creation of ‘Dark Skies’ areas and having local referendums as to whether to have street lighting at all or to switch it off or dim it after a particular time.
- **If (after public consultation and regulatory impact assessments have been completed) alternatives to LED lighting are not available, councils should retain non-LED street lighting in the neighbourhoods of light-sensitive people. They should retain lighting equipment removed from areas where LED lighting has been installed to maintain sufficient stock for this purpose.**
- **Where LED lighting is installed, councils should be aware of, and consider current guidelines. Councils should also be aware that LED lighting complying with these guidelines may trigger fewer health problems in the general public (and for some light sensitive people), they will still infringe the human and disability rights of light-sensitive people and lead to ill-health and social exclusion for many. Current guidelines include:**
 - an upper CCT limit of 2700K on residential roads
 - an upper CCT limit of 2400K in eco-sensitive areas
 - limits on flicker, requiring compliance with IEEE PAR1789.
 - Fitting diffusers to all LED luminaires where the peak luminance exceeds a given threshold of cd/m² to prevent glare.^{2 3 4 5}
- **To begin to repair damage to public health and local ecology councils should:**
 - remove all street lighting with a CCT greater than 5000K within 2 years
 - remove all street lighting with a CCT greater than 4000K within 5 years
 - remove all street lighting which does not comply with IEEE PAR 1789 within 5 years.³

² Revision of the EU Green Public Procurement Criteria for Road Lighting and traffic signals.

³ The All-Party Parliamentary Group for Dark Skies - Ten Dark Sky policies for the government.

⁴ IEEE 1789-2015 – The Institute of Electrical and Electronics Engineers Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers.

⁵ Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, American Medical Association, 2016.

Key questions checklist for councillors

Key issue	Key question	Yes / No
LED street lighting option appraisal, procurement, and monitoring	<ul style="list-style-type: none"> • Did your council's procurement process take into account the findings of key reports into the health and safety of LED lighting, in particular EU Procurement Guidance for LED street lighting, the EU SCHEER report on LED safety and the ANSES report on LED safety? • Did the procurement financial assessment include the cost of scrapping current lighting before its scheduled replacement date and did it include alternatives other than using LEDs? • Did the calculation of CO2 emissions savings include the emissions from manufacturing of new LEDs and the disposal of old units? • Do you get regular reports about whether the promised energy and maintenance savings from LED installations are being made? 	
Consultation with residents and complaints	<ul style="list-style-type: none"> • Were residents consulted before the LED street lighting was introduced? • Did your council pilot the introduction of LED street lighting? • Has your council had complaints about LED street lighting and do you receive a report about complaints? • Are light sensitive people listened to and protected? 	
Regulatory and environmental assessments	<p>Before introducing LED street lighting did your council undertake:</p> <ul style="list-style-type: none"> • An assessment to ensure it met the Public Sector Equality Duty? • An Equality Impact Assessment? • A Disability Impact Assessment? • A Health Impact Assessment? • An Environmental Impact Assessment? • Was the introduction of LED street lighting in line with inclusive by design principles? • Did you receive a copies of these assessments? 	
Protection of the environment and sensitive species	<p>What actions were proposed to mitigate the environmental impacts of LED street lighting and have they been implemented in ecologically sensitive areas?</p> <p>How is their effectiveness monitored?</p> <p>Does the chosen lighting minimise light pollution?</p> <p>Has the council consulted people in rural areas to find out if street lighting is needed or could be switched off or dimmed after a particular time?</p>	

Introduction

7. This report has been prepared by the charity LightAware. It examines the extent to which councils have installed LED street lighting and the measures they have taken to protect the health and safety of residents and minimise the environmental and road safety impacts of this new technology.
8. Street lighting is not a recent invention, it was first recorded in the 4th century BC in the city of Antioch. In 1416 the Lord Mayor of London "ordained lanthorns with lights to be hanged out on winter evenings to limit the activities of cut-throats and footpads". In 1800, the Glasgow Lighting Department was formed and the first Glasgow Police Act made the lighting the streets a statutory duty.
9. Over time the technology used to light the streets has changed from gas to electrical lighting, including the widespread high- and low-pressure sodium lamps to the latest technology, LED lighting. LEDs have become the predominant form of street lighting and domestic lighting in the UK. LEDs made up just 9 per cent of the global lighting market in 2011, but forecasts suggest they will account for 69 per cent by 2020.⁶ As with any new technology, its unintended impacts only become apparent over time. Unfortunately, LED lighting makes some people ill, particularly those who suffer from illnesses that make them light sensitive, such as migraines or lupus, and some people on the autistic spectrum find it difficult to cope with LED lighting.

Local Authorities have been replacing mercury and sodium street lights with LEDs. If this is done purely on the basis of energy efficiency and cost, it is possible to end up with installations that may not be fit for purpose.
Chief Medical Officer for England

Why we created this report

10. While people can, to some extent, choose the type of lighting they have in their homes, they have little choice about street lighting. People across the UK have contacted LightAware to complain that LED street lighting is causing them ill health and leading to social isolation, some have been forced to move home and others have lost their jobs.
11. We have included comments from some of the people who have contacted LightAware throughout the report. Appendix 1 includes their descriptions of the effects that LED street lights have on them and the impact it has had on their lives.
12. Some councils have said that introducing LED street lighting is an essential part of reducing carbon emissions and suggest that by opposing its introduction LightAware is

I don't often go out after dark unless I know there's a 'safe route' through ok lighting. This affects my work and social life and that of my family
Angela, Central Scotland

⁶ Dr Thomas Davies, the Environment and Sustainability Institute, February 2017

not 'being green'. This is absolutely not the case, LightAware fully agrees that reducing carbon emissions is the biggest long-term challenge facing both central and local government. But we believe there are better ways of investing £1 billion pounds to reduce carbon emissions. We also believe that the introduction of LED street lighting in the UK has been rushed through to maximise councils' financial savings without an adequate consideration of the effect on people's health and wellbeing or its full long-term environmental impact.

13. Indeed, one of the biggest problems with LED street lighting is the environmental damage it causes (Chapter 4). Since the introduction of LED lighting, the cost of light as a commodity has fallen sharply and this has resulted in increased night-time illumination and light pollution across the planet. Light pollution is increasing at two per-cent per year and has become a major ecological challenge.⁷

Why LED lighting is different to other types of lighting

14. In the past, most sodium street lights were more or less the same as each other but LED lighting varies enormously. It is different in that it is produced using semiconductors, which can be manufactured with different spectral characteristics and at different colour temperatures (Colour temperature is a way to describe the light appearance provided by a light bulb, giving people an idea of the look and feel of the light produced). This is important as different colour temperatures have different physical psychological and biological effects.
15. Because it is such a new technology, there has been no long-term research into LED safety and environmental impact. In particular the light propagation and distribution characteristics of LED lighting means it cannot be regarded as a like for like replacement of other lighting technologies (Exhibit 1). There are four fundamental issues with the current design of LED street lighting. These are:
- CCT (or more accurately, spectral content distribution)
 - Luminance (excessive brightness and glare)
 - Non-uniform light distribution
 - Flicker
16. These problems can (and should) be mitigated with changes in luminaire design and specification. However, it should not become the type of street lighting of choice until it has been demonstrated that light sensitive people are not made ill by it.

*A central aim of the "lighting revolution" (the transition to solid-state lighting technology) is decreased energy consumption. This could be undermined by a rebound effect of increased use in response to lowered cost of light. **Science Advances, 22 Nov 2017.***

⁷ Artificially lit surface of Earth at night increasing in radiance and extent. Christopher C. M. Kyba et al, Science Advances 22 Nov 2017: Vol. 3, no. 11.

Exhibit 1

LED lighting is a semiconductor light source

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Each LED emits light of only one particular colour. In street lights, this is usually blue, to make white street lights, a powerful blue LED is shone on to compounds called phosphors that absorb blue light and emit yellow light. This yellow light combines with the blue light and appears white to the eye. Most white-light sources emit a range of wavelengths, which, when combined, produce the colour of light perceived by the human eye. The resulting shade of white depends on the blend of phosphors and is measured on the colour-temperature scale. Colour temperature is conventionally expressed in Kelvins, using the symbol K, a unit of measure for absolute temperature. It is measured on a numbered scale, where the higher the number, the 'cooler,' or bluer the light, the lower the number, the 'warmer,' or yellower the light. Examples of the colour temperatures of different forms of lighting include:

- 1700K – Low pressure sodium lamps
- 2400K – Standard incandescent lamps
- 2550K – Soft white incandescent lamps
- 2700K – Soft white LED street lights
- 3000K – Warm white LED street lights
- 4000K – Neutral white LED street lights (the most commonly used type)
- 5000K – Cool white LED street lights, Tubular fluorescent lamps
- 6000K – Sunlight.

Early "white" LEDs were very blue and harsh on the eye. Adding more phosphors to a 'white' LED makes its light look warmer and less harsh, but at the expense of reduced efficiency, as energy is lost in converting high-energy blue photons to lower-energy photons. This means that 'warmer' LEDs are slightly more expensive to run and achieve marginally lower electricity savings.

Unlike other forms of lighting, LEDs are highly directional with light emitted in an arc of around 60 degrees, rather than 360 degrees common in other lighting. LED light is usually emitted from a small, flat, surface, rather than a large, curved one. Because of this the vast majority of LED luminaire designs suffer from the acute drawbacks as they attempt to illuminate wide areas, some distance away from a small, flat light source. Also, LED light is not distributed evenly across its beam but concentrated on its axis. This causes problems of glare, for example, car headlights can be blinding to pedestrians and oncoming traffic when cars go over a speed bump or over the brow of a hill and shine directly in people's eyes. A recent RAC survey found that "the headlights of some newer cars are so bright they are causing a road safety hazard for drivers with as many as two-thirds (65 per cent) of motorists saying they regularly get dazzled by oncoming headlights even though they are dipped".⁸ There are similar issues with LED street lighting where areas directly under the light are brightly illuminated, but with poor illumination between lights (The zebra effect). White LEDs also affect circadian rhythms and cause sleep disturbance when they shine into people's homes.

⁸ <https://www.mynewsdesk.com/uk/rac/pressreleases/motorists-claim-to-being-regularly-left-dazzled-by-modern-vehicle-headlights-2458363>.

About this report

17. This report examines the introduction of LED street lighting across the UK and the resultant impact on people and the environment. LightAware's main objectives were to examine:

- Councils' arrangements for installing LED street lighting, including consultation piloting and regulatory impact assessments.
- The extent and type of LED street lighting currently installed and councils' plans for further installations.
- The potential and actual impact of the installation of LED street lighting on people's health and the environment in the short and long-term.

18. Our methodology included:

- A Freedom of Information request sent to councils in England, Scotland, and Wales (Appendix 2), we received 124 responses, although not every council answered every question.
- Desk research, including an analysis of evidence of the health and environmental impacts of LEDs.
- Discussions with light sensitive people about the impact of LED street lighting in their local area on their health and wellbeing.

Acknowledgements

19. We would like to thank the councils who supplied the information to LightAware, the people suffering from the ill effects of LED street lighting who provided us with information about its effects and LightAware advisors who helped with the design of the questionnaire and commented on technical aspects of this report.

Councils introduced LED street lighting without fully considering its impact

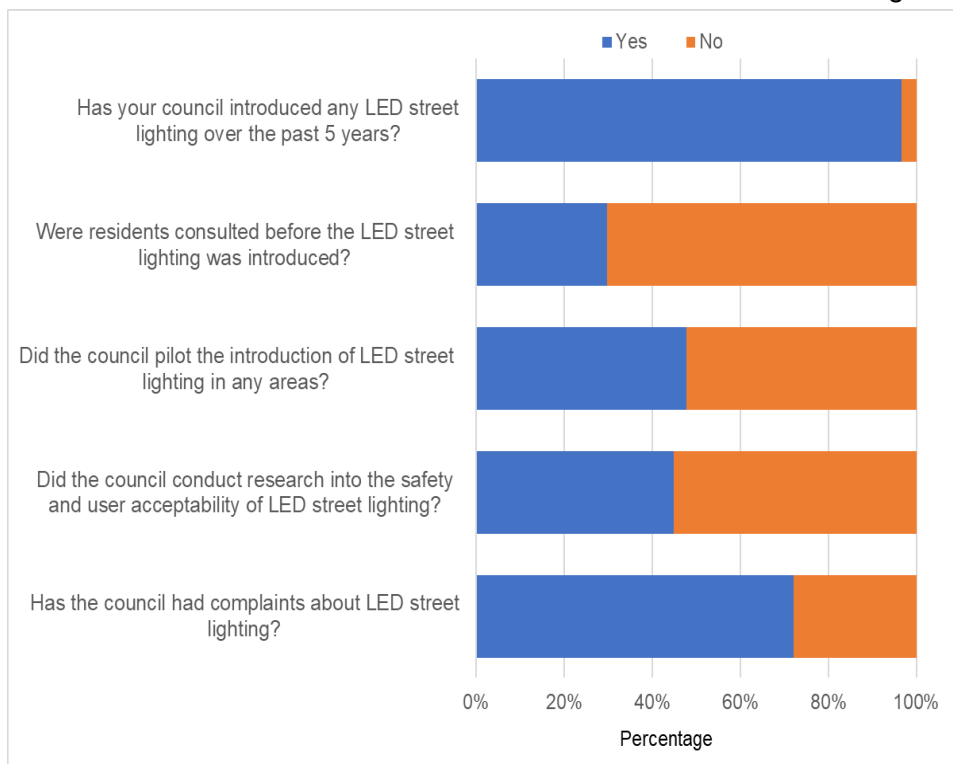
LED street lighting was introduced with little public consultation

20. LED street lighting is radically different from the technologies it has replaced. Because it is such a significant change to the lighting environment of all residents, LightAware believes councils should have piloted its introduction and consulted widely with residents and other stakeholders prior to its introduction. But many did not (Exhibit 2).

Exhibit 2

Consultation on the introduction of LED street lighting

Few councils consulted residents on the introduction of LED street lighting.



... there was a public meeting to discuss the proposals. I was unable to attend but a friend explained about the likely adverse health effects on some residents and that lights were in any case not necessary on the prom. He was told by the elected mayor that everyone wants these lights. In other words, the possibility of anyone becoming ill was deemed to be irrelevant, so they were installed.
Jane, North-East England

Note: 121 councils responded to the first question and, 111, 113, 107 and 111 to questions 2, 3, 4 and 5.

Source: LightAware survey

21. Of the councils who responded to our survey, 117 (97 per cent) had installed LED street lighting over the past five years). However, the majority of councils (70 per cent) introduced LED street lights without any public consultation and only 48 per cent piloted

their introduction. In addition, only 45 per cent of councils conducted research into the safety and user acceptability of LED street lighting before its introduction. Unsurprisingly, around three-quarters of councils have had complaints about LED street lighting.

Few councils undertook appropriate impact assessments before introducing LED street lighting

22. When devising new policies, programmes and projects, public sector bodies need to think about their implications for health, their impact on equalities, people with disabilities, and on the environment. The amount of effort this requires will vary according to the magnitude of any likely change and the difficulty of assessing the potential impacts. In general the process should be to:

- identify any the likely impacts
- assess their magnitude and where they are likely to occur
- value them in monetary terms if this is helpful
- consider uncertainty, risk and their impact on people and the economy
- present the results clearly for the relevant decision makers to consider.

23. It is important to conduct these regulatory impact assessments because many people who are light-sensitive have hidden disabilities. Without undertaking these assessments councils cannot consider their needs in decision-making processes. For example, without a Disability Impact Assessment, councils could fall foul of equalities legislation by failing to anticipate the potential for disability discrimination if light sensitive people react badly to LED lighting. In addition, they would be culpable of failing to make reasonable adjustment if they install lighting and cause detriment to light-sensitive individuals. Street lighting also has significant environmental impacts, for example all bats, their resting and breeding sites are protected and councils disturbing them will be in breach of environmental law.

24. A Health Impact Assessment (HIA) is a way to identify and improve the health consequences of any defined policy or proposed development, including unintended and unanticipated consequences. A HIA includes explicit consideration of how impacts may affect different groups in the population. They produce evidence-based recommendations to inform decision-makers on how they can promote and protect the health and wellbeing of local communities they serve.⁹

25. In understanding the potential impacts of a policy on health and well-being it is important to consult with stakeholders including members of the local community, local health, education, and

Most LED Street lighting makes me feel really awful and unable to function well, with migraines, dizziness, pain, extreme discomfort, being on edge, and a substantial general feeling of malaise. Non-LED street lights are totally fine for me!
Gordon, Oxfordshire

⁹ Health Impact Assessment of Government Policy. A guide to carrying out a Health Impact Assessment of new policy as part of the Impact Assessment process. Department of Health.

other professionals with an understanding of the community. However, only 17 per cent of councils in our survey conducted a health impact assessment before introducing LED street lighting. Similarly, one would also expect councils to conduct an assessment to ensure that the lighting meets requirements under the Equality Act 2010. It is appalling that so few councils have undertaken regulatory assessments.

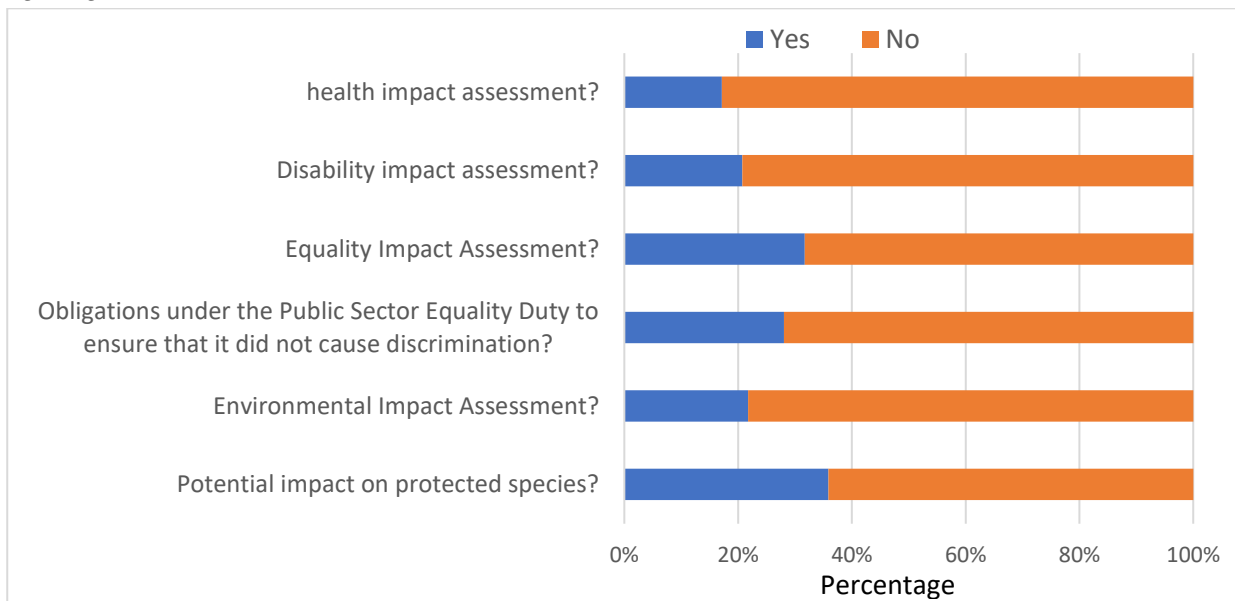
26. Similarly, councils should undertake assessments of the impact of policies other important areas (Exhibit 3), which shows that:

- only 22 per cent of councils undertook an Environmental Impact Assessment.
- 32 per cent conducted an Equality Impact Assessment
- 21 per cent conducted a Disability Impact Assessment
- 28 per cent conducted an assessment of the impact on their Obligations under the Public Sector Equality Duty to ensure that it did not cause discrimination.

Exhibit 3

Assessments undertaken prior to the introduction of LED street lighting

Few councils undertook proper health and environmental prior to the introduction of LED street lighting.



Source: LightAware survey

27. LightAware also believes that councils should have taken account of ‘inclusive by design’ features when making significant changes to the street lighting environment.¹⁰ Inclusive Design is the design of an environment so that it can be accessed and used by as many people as possible, regardless of age, gender, and disability. It applies to surrounding open spaces, wherever people go about everyday activities. This includes shops, offices, hospitals, leisure facilities, parks, and streets. To do this, built environment professionals,

¹⁰ See <https://inclusivedesign.scot/what-is-inclusive-design/#scot-leg>.

including lighting engineers should involve potential users at all stages of the design process. Where possible, it is important to involve disabled people, including people with hidden disabilities, such as lupus sufferers, in the design process.

Most councils have not taken into account the recommendations of reviews of the health impacts of LED lighting

28. We asked councils whether they had taken into account the findings of three major reports into the health and safety of LED lighting (Exhibit 4). These were:

- The EU SCHEER report on LED safety
- EU Procurement Guidance for LED street lighting
- ANSES report on LED lighting.

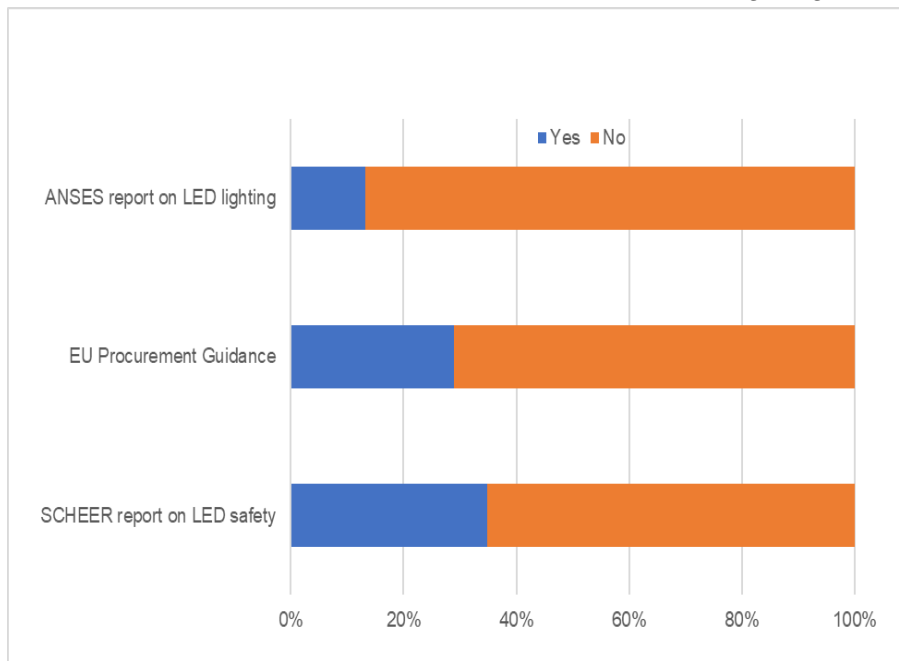
After years of lobbying my council, they have switched some of the LED street lighting on my street back to amber sodium lights. But there's no guarantee that they will continue to do so and it hardly helps that LED lights are now almost everywhere!

Gordon, Oxfordshire

Exhibit 4

The percentage of councils taking into account major research reports into the health and safety of LED street lighting

Few councils have taken the latest research about LED lighting into account.



My quality of life is impacted greatly due to me being unable to go anywhere when streetlamps are lit. I can only go out during day-time hours which restricts any social or practical daily living events. I am unable to give lifts to my children outside of daytime hours, my friends and family are very understanding but have to work around my needs.

Jennifer, East Midlands

Source: LightAware survey

29. The EU Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) published its opinion on Potential risks to human health of Light Emitting Diodes (LEDs) in June 2018. The report concluded that:

- there is no evidence of direct adverse health effects from LEDs in normal use (lighting and displays) by the general healthy population (i.e. the adult population)

excluding children, older people and people suffering from light sensitive conditions).

- Some people report that they are sensitive to flicker from LEDs.
- Children have a higher sensitivity to blue light and although emissions may not be harmful, blue LEDs (between 400 nm and 500 nm) may be very dazzling and may induce photochemical retinopathy, which is a concern especially for children below three years of age.
- Older people may experience discomfort with exposure to light that is rich in blue light.
- Either discomfort glare or disability glare can be temporarily caused by vehicle LED lights, and particularly daylight running lights and headlights.
- Light sources that emit more short-wavelength light, as do some types of LEDs, will have a larger effect on the circadian rhythms at equal optical radiance, duration, and timing of exposure. ¹¹

Street lights in my area/street were changed over 4 years ago from sodium halide. Their effect on me was so devastating I have barely left the house or even opened my front door in the evening since they were installed. I can also be affected during the day as many LEDs are actually on permanently, presumably because they are defective or have light-sensitivity settings that are inappropriate.
Jane, North-East England

30. The SCHEER report makes clear the potential adverse health effects of blue light. It is surprising therefore that councils have continued to procure street lighting with a substantial blue component, particularly when suitable alternatives are available.

31. The revision of the EU Green Public Procurement Criteria for Road Lighting and traffic signals was published in 2019 after the SCHEER report. It is applicable in the UK until the UK Government produces its own post-Brexit guidance. LightAware believes that the UK Government will not water down the environmental and health protections included in the EU guidance. The guidance on procuring street lighting provides clear advice that “***in order to reduce the risk of human annoyance, the CCT of light sources shall be ≤3000K and a dimming or switch-off programme shall be implemented****.” ¹²

32. The report goes on to deal specifically with street lighting saying that ‘it is generally more powerful than indoor light sources and short-term exposure to very intense visible radiation (i.e. light) can induce cell damage or cell death due to free radical formation via photoreactive pigments’ and that ‘shorter wavelength light (400-600nm) is capable of penetrating into cell organelles and producing reactive oxygen species in mitochondria, which may lead to apoptosis. The concerns with blue light are more pronounced with older people.

¹¹ Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), Opinion on Potential risks to human health of Light Emitting Diodes (LEDs), European Union, 2018.

¹² Revision of the EU Green Public Procurement Criteria for Road Lighting and traffic signals, European Union, 2019.

33. The report concludes that “Going beyond human health impact, concern with the effect of blue light on nocturnal species and its much higher potential contribution to skyglow are sufficient motives for promoting restrictions on blue light in a number of areas (e.g. parks, gardens, protected areas and intrinsically dark areas) where “A dimming and/or switch-off programme shall be implemented for any other ecologically sensitive areas”.

34. A third major health study produced by the French Government’s institute for health resulted in the ANSES report (2019). It concluded that “The new scientific data confirm the 2010 result regarding the toxicity of blue light to the eye, which can lead to failing eyesight. They show short-term phototoxic effects associated with acute exposure and long-term effects associated with chronic exposure, which increase the risk of developing age-related macular degeneration (ARMD). In addition, the expert appraisal showed that even very low levels of exposure to blue light in the evening or at night disrupt biological rhythms and therefore sleep.”¹³

I made the decision several years ago, that I would simply no longer leave the house after dark. This practically means making sure I am home by 2.30pm in midwinter. At the time of writing, my immediate area is still lit by sodium street lights. On the rare occasions I do go out of my area after dark, I have to get a taxi and cover my eyes with a tight scarf so that no light enters. This makes me feel vulnerable, and it is not fool proof. Staying in seems the best policy.
Emily, Lancashire

35. Although the report warns about the risks of blue light from mobile phones and tablets as a key risk for children, they conclude that even very low levels of exposure to blue light in the evening or at night disrupt biological rhythms. This is significant evidence that the introduction of 4000K LED street lighting can have a disruptive effect on children’s sleep.

36. Taking messages these from these reports together with those from our survey, LightAware can only conclude that councils were either unaware of the health impact of LED street lighting on their residents or saw financial savings as a higher priority.

Recommendations

- **Councils should introduce a moratorium on the roll out of LED street lighting and maintain current street lighting until it reaches the end of its useful life or until such time that safe replacements can be found. Councils should retain a supply of parts to help them maintain current street lighting.**
- **Where street lighting has come to the end of its economic life and needs to be upgraded, councils should consult communities about replacement street lighting, including:**
 - **an assessment to ensure that it meets the Public Sector Equality Duty**

¹³ Opinion of the French Agency for Food, Environmental and Occupational Health & Safety on the “effects on human health and the environment (fauna and flora) of systems using light-emitting diodes (LEDs) April 2019.

- **undertaking Regulatory Impact Assessments covering equalities, health, disability, and the environment**
- **identifying light sensitive residents and taking steps ensure they are not socially excluded, including retaining conventional street lighting in their neighbourhood**
- **in rural areas, encouraging the creation of ‘Dark Skies’ areas and having local referendums as to whether to have street lighting at all or to switch it off or dim it after a particular time.**
- **If (after public consultation and regulatory impact assessments have been completed) alternatives to LED lighting are not available, councils should retain non-LED street lighting in the neighbourhoods of light-sensitive people. They should retain lighting equipment removed from areas where LED lighting has been installed to maintain sufficient stock for this purpose.**
- **Where LED lighting is installed, councils should be aware of, and consider current guidelines. Councils should also be aware that LED lighting complying with these guidelines may trigger fewer health problems in the general public (and for some light sensitive people), they will still infringe the human and disability rights of light-sensitive people and lead to ill-health and social exclusion for many. Current guidelines include:**
 - **an upper CCT limit of 2700K on residential roads**
 - **an upper CCT limit of 2400K in eco-sensitive areas**
 - **limits on flicker, requiring compliance with IEEE PAR1789.**
 - **Fitting diffusers to all LED luminaires where the peak luminance exceeds a given threshold of cd/m² to prevent glare.^{14 15 16 17}**
- **To begin to repair damage to public health and local ecology councils should:**
 - **remove all street lighting with a CCT greater than 5000K within 2 years**
 - **remove all street lighting with a CCT greater than 4000K within 5 years**
 - **remove all street lighting which does not comply with IEEE PAR 1789 within 5 years.³**

¹⁴ Revision of the EU Green Public Procurement Criteria for Road Lighting and traffic signals.

¹⁵ The All-Party Parliamentary Group for Dark Skies - Ten Dark Sky policies for the government.

¹⁶ IEEE 1789-2015 – The Institute of Electrical and Electronics Engineers Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers.

¹⁷ Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, American Medical Association, 2016.

Councils are introducing LED street lighting to save money

37. Since 2010 councils have faced severe spending pressures because of real-terms reductions in revenue support grant and increasing demands on services in areas such as social work driven by an ageing population. As a result, councils have been looking for savings in other areas to offset these severe budget pressures. The cost-saving potential of LEDs may have appealed to councils looking to achieve savings. Reducing carbon emissions has provided an additional reason for change.
38. In an effort to maximise savings, councils have installed lighting that provides the greatest efficiencies (lighting with a colour temperature of 4000K or above). Unfortunately, this type of lighting also has the biggest negative impacts on people's health and on the environment.

Councils are spending substantial sums on LED street lighting

39. LED street lighting can reduce energy consumption but the initial cost of LED lighting is higher than conventional lighting and several years of energy savings may be required to recoup the initial expense. To help fund this kind of investment, the UK Government set up the Green Investment Bank (GIB), which provides funding to councils to invest in LED street lighting. Other forms of finance are also available such as the Public Works Loan Board, Prudential borrowing (in Scotland) and other green investment banks such as Salix.¹⁸
40. Overall in the 90 councils answering the financial questions in our survey, spending on street lighting increased substantially over the four-year period to 2017/18.
- 2014/15 - £59 million
 - 2015/16 - £79 million
 - 2016-17 - £198 million
 - 2017/18 - £203 million.
41. Councils also indicated that they intended to spend a further £375 million over the following three years converting their street lights to LED, although a number indicated they were unsure of their plans. Our survey covered around two-thirds of councils overall and extrapolating the data from our survey suggests that well in excess of £800 million has been spent on LED street lighting and that total expenditure will reach over £1.3 billion.

¹⁸ Many councils' LED schemes are funded by Salix finance, a government funded not-for-profit organisation. It provides interest-free capital for public sector organisations to increase their energy efficiency.

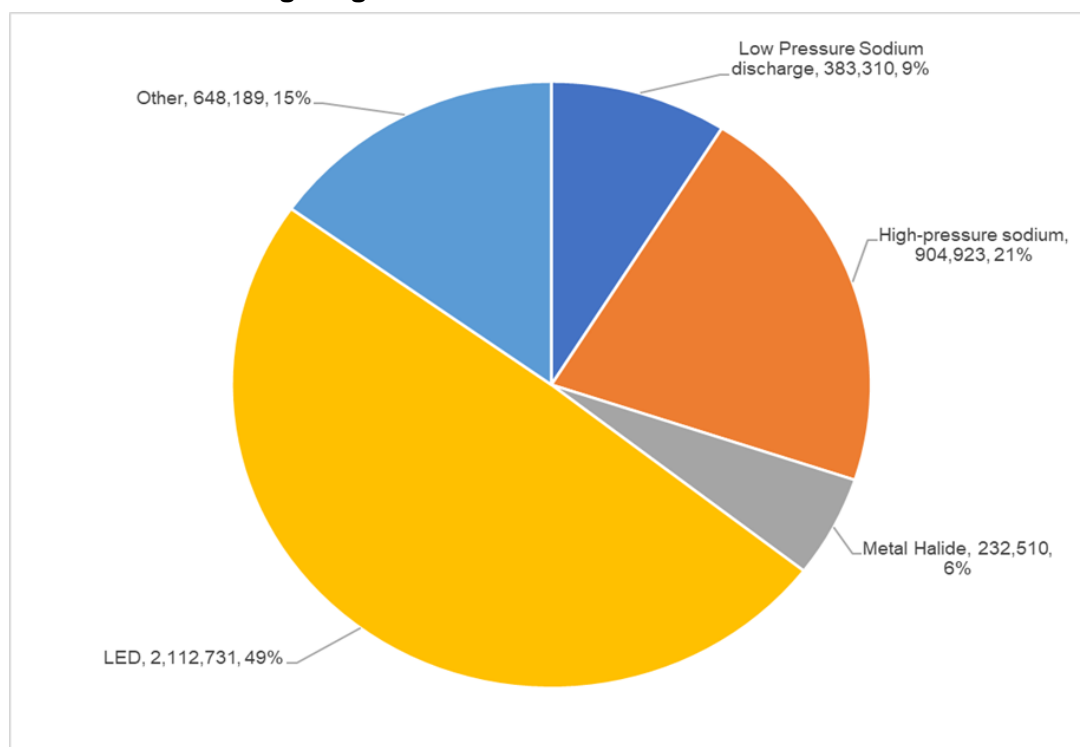
LED street lighting is becoming the norm across the UK

42. At the time of our survey, in late 2019, LED street lights made up almost half (49 per cent) of street lights, with high pressure sodium lighting making up twenty-one percent of the total (Exhibit 5). LED street lights will now make up over half of the street lights in the UK and this will increase significantly with many councils converting all of their street lighting to LED. By the end of 2021, well over 80 per cent of councils' street lighting will be converted to LED with the majority being 4000K or over and around 7 per cent being 2700K or less, the standard set for lighting in residential areas.¹⁹

43. In her 2017 Annual Report to Local Authorities, the Chief Medical Officer for England said "Local Authorities have been replacing sodium street lights with LEDs. If this is done purely on the basis of energy efficiency and cost, it is possible to end up with installations that may not be fit for purpose. Some streetlight luminaires have LED sources that can be seen physically projecting below the luminaire, becoming a glare source or light pollution". Our survey shows that, unfortunately the Chief Medical Officer for England's warning has not been heeded.²⁰

Exhibit 5

Current UK street lighting



Source: LightAware survey of councils

¹⁹ Revision of the EU Green Public Procurement Criteria for Road Lighting and traffic signals, EU, 2019.

²⁰ Annual Report of the Chief Medical Officer 2017, Health Impacts of All Pollution – what do we know? Chapter 4 page 5.

The most damaging street lights make up almost three-quarters of street lighting installed by councils

44. Exhibit 6 shows the breakdown of the colour temperature of LED street lights installed by the Local Authorities in our council survey. Almost three quarters are the 4,000K and above, while only 5 per cent are those under 3000 degrees recommended by procurement guidance for use in residential areas.

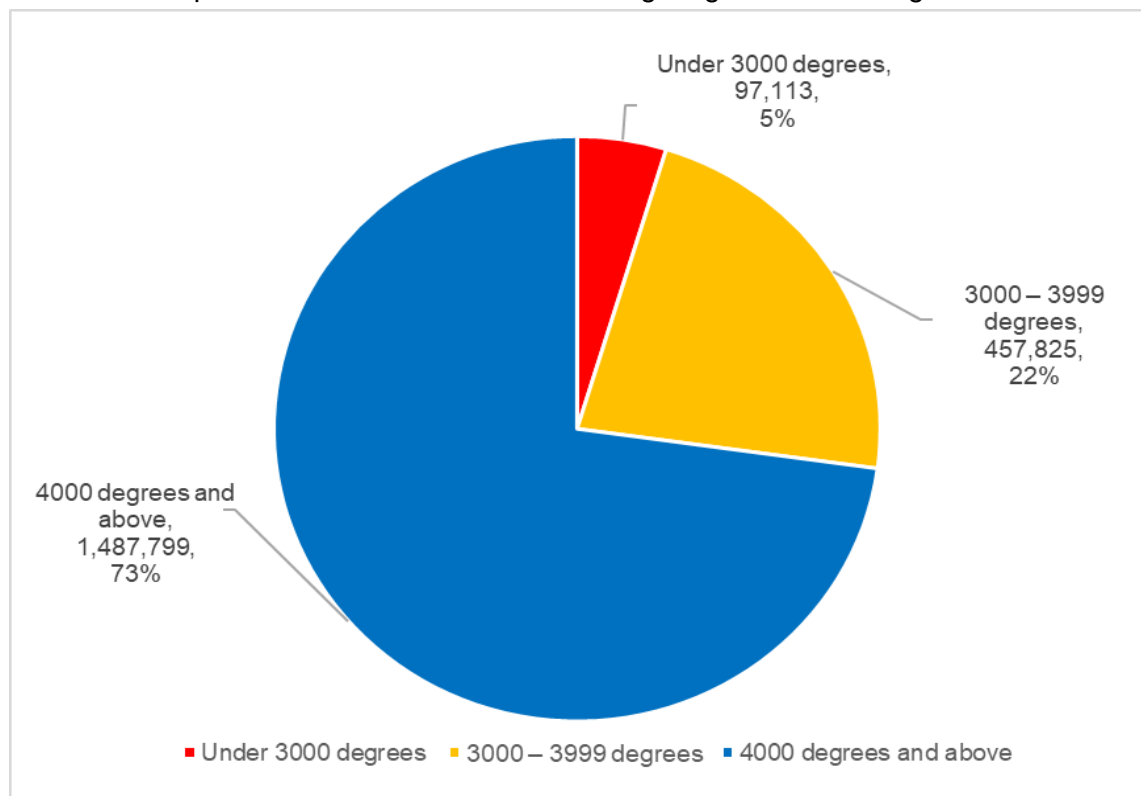
Some lights are better than others but the bad ones give me a terrible headache and nausea that kicks in after 2- or 3-minutes exposure and takes a week to go away. The symptoms are like recovering from gastroenteritis and I am unable to socialise or leave the house for a week until they go away.

**Julia,
Cambridgeshire**

Exhibit 6

Colour temperature of LED street lighting installed across the UK

Almost three-quarters of the current LED street lighting is 4000K or higher.



Source LightAware survey of councils

45. Of the 97 councils that provided information, over half (55 per cent) used solely LEDs with a colour temperature of 4000K or above. Only nine councils used a significant quantity of lower colour temperature LEDs (under 3000K). (Exhibit 7)

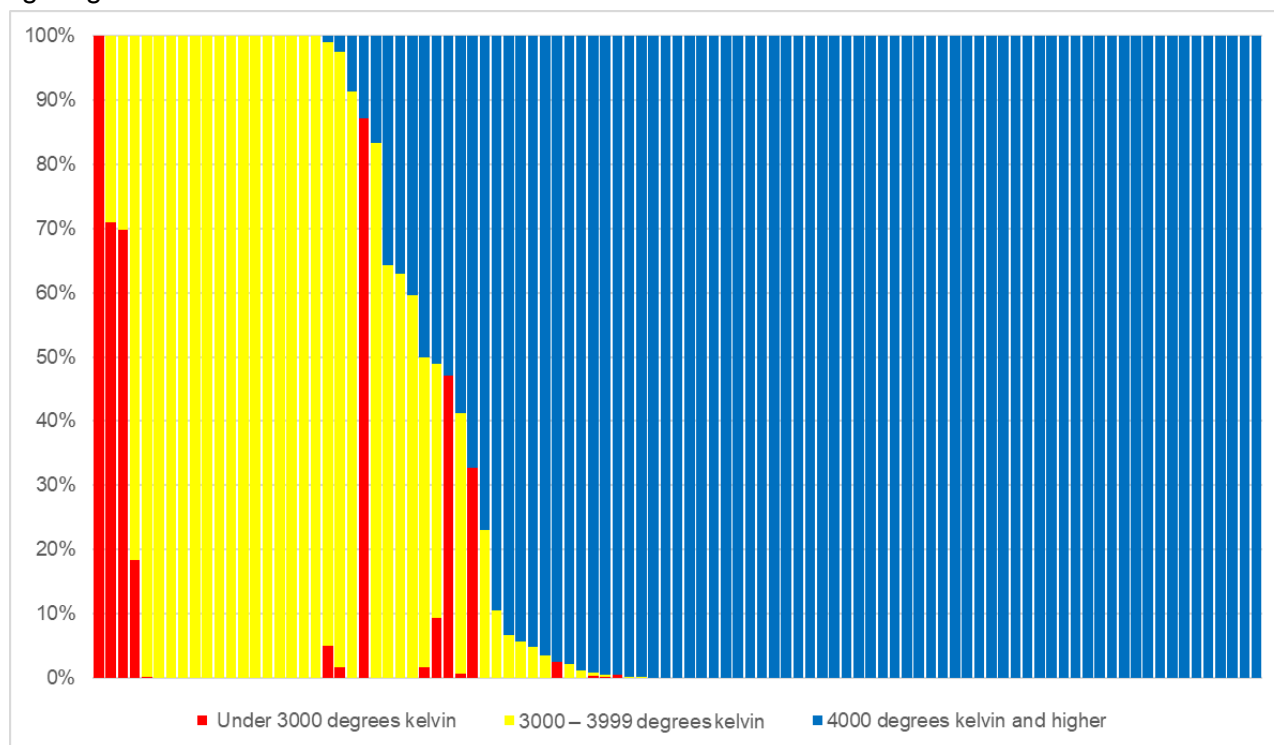
46. The only council where all its LED street lighting was 2700K or less was the London Borough of Westminster, other councils with large numbers of these lower colour temperature LEDs, included Birmingham City Council (87per cent), Hartlepool Borough Council (71 per cent), Buckinghamshire County Council (70 per cent), Perth and Kinross Council (47per cent) and West Lothian Council (33per cent).

Local Authorities have been replacing mercury and sodium street lights with LEDs. If this is done purely on the basis of energy efficiency and cost, it is possible to end up with installations that may not be fit for purpose
Chief Medical Officer for England

Exhibit 7

Colour temperature of LED street lighting installed in each council

Over half of councils installed only LED street lighting above 4000K, but very few installed lighting under 3000 K.



Source LightAware survey of councils

47. Exhibit 8 shows the colour temperature of LEDs installed in different types of council. London Boroughs used the fewest high colour temperature LEDs and Scottish councils used the most. Although it appears that Scottish Councils use more LED street lights with a lower colour temperature, almost all of these were in Perth and Kinross and West Lothian Councils.

None as good as old sodium halide. But with LEDs the cooler the colour temperature the worse the effect.

**Elizabeth,
Southern England**

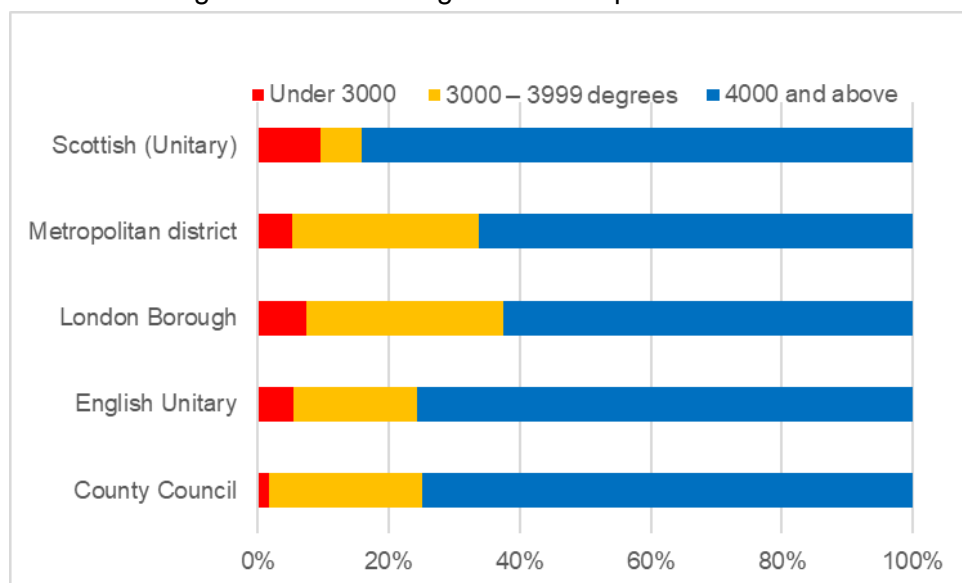
Bright blue/white ones are much worse.

**Angela,
Central Scotland**

Exhibit 8

Colour temperature of LED street lighting installed in types of council

London Boroughs used fewest high colour temperature LEDs.



Source LightAware survey of councils

Problems with LED street lighting are becoming apparent, including health and safety problems

48. Although LED lighting is widely promoted as having lower energy consumption, because of the way LEDs produce light they also lead to reduced levels of illumination. Many people do not like the ambiance usually produced by the LEDs with colour temperatures of 4000 Kelvins or higher. It is often called prison lighting or 'dementor lighting' because of its cold soulless feel.²¹

²¹ In J K Rowling's Harry Potter books, Dementors are dark creatures that consume human happiness, creating an ambiance of coldness, darkness, misery and despair.

49. Because LED is a very new technology, it needs to be planned and installed with a high level of expertise. A number of people have complained about lights in the wrong places causing patches of no light at all, and other areas that are too bright. This is particularly the case where LEDs have been installed on existing lamp posts, leading to alternating light and dark patches of road, sometimes known as the 'zebra effect', which may cause psychological and visual disturbance to drivers. In addition, the sharp lighting cut-off can lead to 'pavement ghosts' where people wishing to cross a road are invisible to drivers until they step out into the road. ²²

Street lights in my area/street were changed over 4 years ago from sodium halide. Their effect on me was so devastating I have barely left the house or even opened my front door in the evening since they were installed. I can also be affected during the day as many LEDs are actually on permanently, presumably because they are defective or have light-sensitivity settings that are inappropriate.

Jane,
North-East England

50. An additional danger is the loss of night vision because of the accommodation reflex of drivers' eyes. As drivers emerge from an unlighted area into a pool of light, their pupils quickly constrict to adjust to the brighter light, but as they leave the pool of light the dilation of their pupils to adjust to the darkness is much slower, so their vision is impaired. As a person gets older the eye's recovery speed gets slower, so driving time and distance under impaired vision increases. This is one reason why many older people choose not to drive at night. It is exacerbated by LED vehicle headlights and street lighting and may lead to increased social isolation for older people. ²³

51. LED street lights emit blue and green light in large amounts compared to the yellow and orange high- pressure sodium lights that they typically replace. The human eye is very sensitive to blue and green when dark-adapted, which magnifies the effect of light pollution - commonly known as sky glow. This is also likely to effect bird migration and the behaviour of nocturnal animals.

52. Glare is another common problem. A French government report published in 2013 indicated that a luminance level higher than 10,000 cd/m² causes visual discomfort whatever the position of the lighting unit in the field of vision. As the emission surfaces of LEDs are highly concentrated point sources, the luminance of each individual source can be 1000 times higher than the discomfort level. The level of direct radiation from this type of source can therefore easily exceed the level of visual discomfort. ²⁴

53. A common problem is that, to reduce costs, some councils specify very small luminaires (typically 16 LEDs) at high drive currents, which with inevitably result in high luminance and glare. Glare could be reduced by, for example, specifying a 24 LED luminaire at lower drive current to achieve the same output.

²² Design of LED freeform optical system for road lighting with high luminance/illuminance ratio Zexin Feng, Yi Luo, and Yanjun Han. Optics Express, Volume 18, Issue 21.

²³ Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), Opinion on Potential risks to human health of Light Emitting Diodes (LEDs), European Union, 2018.

²⁴ ANSES, the French Agency for Food, Environmental and Occupational Health & Safety, September 2013

54. For current installations, one option would be to fit diffusers, another to be to push for councils to 'upgrade' their luminaires to the larger specification with dimming. Councils need to be held accountable for the problems they have caused and, where there is a complaint from the public and they must take ownership. Merely sticking shields on luminaires or ignoring residents' complaints is not acceptable and, in some cases, will be in breach of disability discrimination legislation.

I contacted the council and they told me that the person in charge of street lighting safety had left.

**Julia
Cambridgeshire**

LED colour and brightness change over time

55. The projected lifetime of LED street lights is usually 10 to 15 years, but no LED street lighting products have been in service long enough to confirm manufacturers projections. Lifetime estimates are produced with the LED packages operating continuously in a temperature-controlled environment, which do not necessarily reflect real-world operating conditions. In operation, LEDs will be subjected to electrical, thermal and humidity stresses simultaneously, but reliability tests that consider all these three stresses together are uncommon. Electronics failures in the driver or degradation of optical components can occur long before LED depreciation causes failures.²⁵

56. The luminosity of LEDs decreases over time, rather than fail most LEDs tend just to get dimmer. Temperature fluctuations during operation may also intensify degradation mechanisms. In addition, the colour temperature can also change, depending on the design of the LED package. LEDs can also become bluer over time if there is a loss of phosphor efficiency because of chemical change, temperature effects or fractures of the binder in the phosphor-binder layer. It will be interesting to find out the impact of British weather on the long-term reliability of LED street lighting and the degree to which the promised financial savings actually materialise. For example, Dundee City Council have already reported that financial savings have not materialised.²⁶

Recommendations

- **To prevent glare, the UK government should introduce standards for LED luminaires, including a ban on exceeding a peak luminance threshold.**
- **Councils should take steps to reduce glare from current LED street lighting, for example by fitting diffusers.**
- **Councils should publish reports showing whether promised financial savings from the introduction of LED street lighting have been achieved.**

²⁵ LED Luminaire Reliability: Impact of Colour Shift, Next Generation Lighting Industry Alliance LED Systems Reliability Consortium, April 2017.

²⁶ Dundee City Council, Policy and Resources Committee, 13 January 2020, Report on revenue monitoring.

LED street lighting makes some people ill

57. The main health risks associated with LED-based lighting systems are:

- their high luminance (a large amount of light emitted by a point source leading to excessive brightness and glare)
- stroboscopic effects (flicker)
- CCT (their unusual emission spectrum, with a high proportion of blue light)
- Non-uniform light distribution.

58. These are discussed separately below, but it is likely that the combination of these effects is a significant cause of the adverse health and environmental impacts described.

High luminance can cause problems with glare

59. The human eye can adapt to a wide range of light levels from bright sunlight to almost total darkness. However, comfortable vision requires a limited range of light levels at any particular time and excessive light levels and luminance contrasts can lead to glare. Many LED street lights have their high-luminance LED chips visible, which can be a source of glare for dark adapted eyes. Glare can be experienced as disability glare or discomfort glare:

- **Disability glare** affects the ability to see and leads to some degree of temporary loss of vision and is produced by high luminance in a lower luminance scene, for example at night when a car with LED headlights comes over the brow of a hill or goes over a speed bump. ²⁷
- **Discomfort glare** causes irritation, anxiety, visual fatigue, and eyestrain and can adversely affect wellbeing ²⁸ Depending on an individual's sensitivity it can also cause dry or watery eyes, itchiness, tense muscles, breakdown of vision, blurred or double vision, headaches and fatigue.

(LED street lights) cause my heart to race, make me feel nauseated, dizzy, disorientated, make my skin hot and inflamed and cause my nerves to become heightened in my skin and immense itching which also affects my sleep. Exposure to artificial lighting can cause my Lupus to flare.
Jennifer, East Midlands

60. A report by the American Medical Association (AMA) concluded that there were significant human and environmental concerns are associated with short wavelength (blue) LED emission from LED street lights. These included:

²⁷ The Lighting Handbook. London, Society of Light and Lighting, 2009.

²⁸ Stone PT. A model for the explanation of discomfort and pain in the eye caused by light. Lighting Research and Technology, 41, 2009, 109-121.

- LED lighting is an inherently bright point source and can cause eye fatigue. If it directly shines into people's eyes, it causes the pupil of the eye to become smaller leading to worse night-time vision
- improper design of lighting fixtures resulting in glare, creating a road hazard
- many residents are unhappy with bright with community complaints of glare and a "prison atmosphere".²⁹

(LED street lights) cause Migraine, burning red rash, nausea, circulation slowing so cold, followed by fatigue, joint pain. Elizabeth, Southern England

61. An extreme example of glare is daylight-running lights on cars. These are clearly visible to other road users and pedestrians. At night, if they do not dim, they can be dazzling and more so for young children (who have higher transmission of light through to the retina) and for older people (who will suffer from scattering of the light, particularly in the lens of the eye). Older drivers, in particular, will be dazzled by oncoming vehicles with the risk that they may not see hazards until too late. The problem is exacerbated by fog and rain.

LED flicker can cause migraines and also presents a safety hazard

62. Circuitry within the LED converts mains alternating current to the low voltage direct current required by the LED. Unfortunately, some circuitry is inadequate in reducing the variation in the power supply and this generates flicker. LEDs vary in their degree of flicker; some do not flicker at all while others flicker badly. There is no reason why LEDs can't be flicker free, except cost. The Swedish Government has calculated that the cost of eliminating flicker is equivalent to around 10 pence per LED unit.³⁰

63. Flicker is mainly perceived towards the edges of the visual field, which is more sensitive to motion. Flicker can cause ill-health, even if it is so rapid that you are unaware of it. It can cause headaches, eyestrain, migraines, fatigue and disturbs the control of eye movements. Unlike other light sources, which may flicker slightly, the flicker from LEDs can change almost instantly between bright and dark. In some circumstances, people see a trail of the same image of a lamp repeated one after the other, each time their eyes

Some of the LED sources assessed by Public Health England and others vary in illuminance at a frequency of 100 hertz. At the extreme, the LEDs switch on and off 100 times per second. This is of concern for a number of reasons. Some people seem to be very sensitive to this light modulation, resulting in headaches, migraine and less specific feelings of malaise.
Chief Medical Officer for England

²⁹ Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, American Medical Association, 2016.

³⁰ https://www.eceee.org/static/media/uploads/site-2/news/swecovernotesvm_study_181212.pdf

move across it, known as a phantom array, it is particularly noticeable with the LED tail lights of cars. ³¹

64. Flicker can also disrupt the movement control of the eyes and force the brain to work harder, causing discomfort and migraine in some people. Flicker stresses the nervous system and rapid changes in light subconsciously activate the alarm system and have different effects on people depending on the frequency. This explains the anxiety and stress many people feel when exposed to flickering LEDs. For people suffering from migraine, LED flicker commonly induces feelings of dizziness and pain within 20 minutes of switching them on, but for some it can be instantaneous. Flicker doesn't only affect people; chickens do not lay eggs due when exposed to the stress caused by flickering light. ³²
65. To ensure both public health and safety, it is important that councils ensure that street lights are flicker free. Unfortunately, some street lights flicker badly and these be should be replaced as a matter of priority. Checking for flicker is relatively simple with a smartphone camera, and apps are available for that allow users to measure the degree and frequency of flicker. LightAware would encourage people to report flickering street lights to their local council.

LED street lights can cause sleep disturbance

66. A core health concern about LED street lighting is the disruption of people's circadian rhythms leading to disturbed sleep patterns. Humans have a natural body clock that has an approximate 24-hour cycle. At dusk, and in the absence of electric lighting, humans begin the transition to night-time physiology to prepare for sleep. The blood concentration of the hormone melatonin rises, body temperature drops, sleepiness grows, and hunger subsides.
67. In the early 2000s a new type of sensor was discovered in the eye, in addition to the rods and cones, which was also sensitive to light. These intrinsically photosensitive retinal ganglion cells (iPRGCs) were identified as the main sensors for entraining our circadian rhythms. Light is the main trigger that ensures that our circadian rhythms are properly maintained and retinal light exposure is the dominant synchronizer of the human circadian system. Recent evidence has revealed that the human circadian system is

The intense whiteness and glare from many LED street lights make me feel immediate pain and discomfort and after a while I feel sick and get headaches, I also find it very difficult to get off to sleep and I often lay awake all night if I have been exposed to LED lights.
Jim, Manchester

³¹ Flicker can be perceived during saccades at frequencies in excess of 1 kHz,

Lighting Research and Technology 45(1):124-132 February 2013, J. E. Roberts, Arnold J Wilkins,

³² "Light flicker: Determination and Assessment. Discussion Peter Erwin Discussion Paper Oct 2017.

more sensitive to evening light than previously thought and that there are also substantial differences between individuals in light-sensitivity.^{33 34}

68. Unfortunately, many LED street lights have a spectrum containing a spike at the wavelength that most effectively suppresses melatonin during the night (Exhibit 9). It is estimated that a “white” LED lamp is up to 5 times more powerful in disrupting circadian physiology than a high-pressure sodium light.³⁵
69. Recent large surveys have found that brighter residential night-time lighting is associated with reduced sleep time, dissatisfaction with sleep quality, night-time awakenings, excessive sleepiness, impaired daytime functioning, and obesity. Disruption of the circadian system can have a major impact on sleep quality and daytime alertness, which in turn impacts wellbeing and safety. It is a bit like having permanent jet lag.
70. The human eye is not equally sensitive to all wavelengths in normal daylight vision, known as photopic vision, the eye has a peak sensitivity at 555 nanometres (green). LED street lights producing a peak of blue light, which is the hardest colour to see (Exhibit 9). A lot of the blue light produced by LEDs is not useful for human vision which may partially account for the comments about prison / dementor lighting (although it is useful for CCTV cameras).

³³ Phillips, A. J. K. et al. High sensitivity and interindividual variability in the response of the human circadian system to evening light. *Proc. Natl. Acad. Sci. USA* 116, 12019–12024. <https://doi.org/10.1073/pnas.1901824116> (2019).

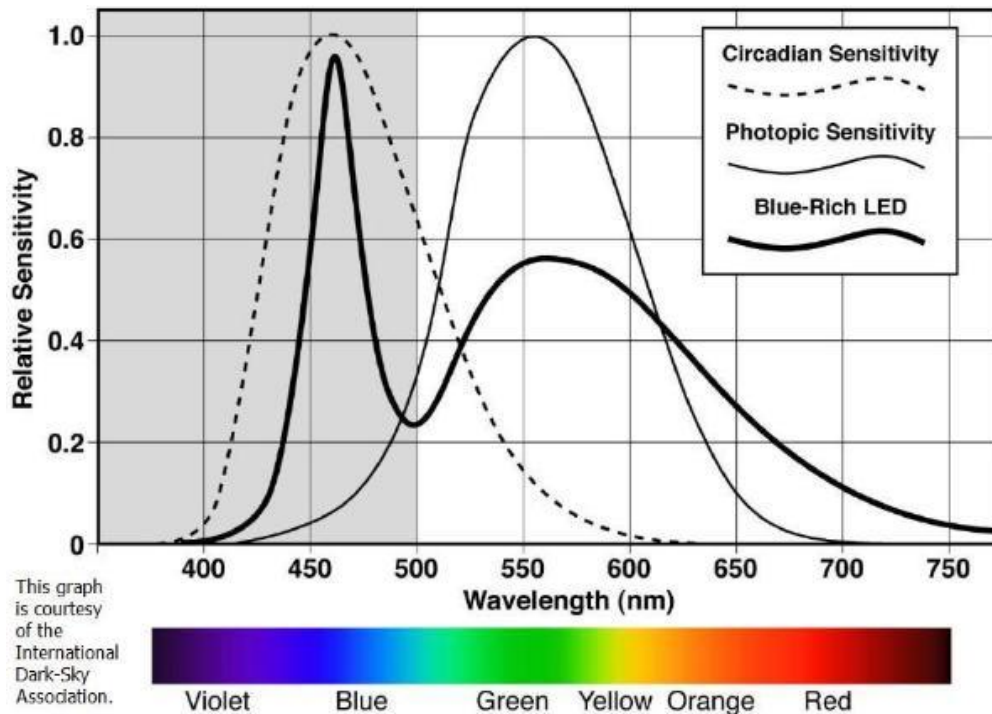
³⁴ Boivin, D. B., Duffy, J. F., Kronauer, R. E. & Czeisler, C. A. Dose–response relationships for resetting of human circadian clock by light. *Nature* 379, 540–542 (1996).

³⁵ Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting, American Medical Association, 2016.

Exhibit 9

Human photopic and circadian sensitivity curves displayed against a typical blue-rich LED light source spectrum

Blue rich LEDs have a peak at the wavelength that effects human sleep wake cycles but is less suitable for human vision.



Source: International Dark Sky Association.

LED street lighting exacerbates a number of light sensitive illnesses

71. As well as these effects on the population as a whole discussed above, people suffer from different types of light-sensitivity that are exacerbated by LED street lighting (Exhibit 10). People suffering from these illnesses have contacted LightAware for advice about their problems with LED street lights. Councils' responses have varied, some have been helpful, for example by maintaining sodium lighting in their local area but others have been less helpful and some people have been forced to move home to escape their effects.

Our village is in the process of changing the streetlamps to LED. The Parish Council has agreed not to change the lamp in the road where I live and plan to keep the 'old' bulbs from the lamps being changed so that there are spare supplies for the one in my road.

Jennifer, East Midlands

Exhibit 10**Illnesses that can be triggered or made worse by LED street lighting****Migraine**

Light sensitivity is so common in people with migraine that it is itself a diagnostic criterion for the illness. Migraine is estimated to affect one in seven people in the UK and can cause many symptoms, including a throbbing one-sided headache, nausea and vomiting and visual disturbances. For many migraineurs (32 – 40 per cent) light-sensitivity is intricately linked to their condition.

LED lighting may have greater flicker than traditional light sources and some can effectively switch on and off hundreds of times every second. Poorly specified or poorly installed LED street lighting can be too bright, creating glare which caused migraines in susceptible individuals and eye pain in others.

Systemic Lupus erythematosus (lupus)

Lupus is an autoimmune disease in which the body's immune system mistakenly attacks healthy tissue. About one person in 3,500 has lupus and it is more common in women than in men. Up to 70 per cent of people with lupus have some skin symptoms. Lupus UK estimates that about 30,000 sufferers are adversely affected by fluorescent lighting. LEDs can be better than fluorescent lighting for some as they don't emit UV light, but some lupus sufferers cannot tolerate LEDs either. Cool white and bright white LEDs used in street lighting emit short-wavelength blue light, which is risky for many lupus sufferers. Lupus sufferers who cannot go out in sunlight can be effectively trapped in their homes at night as well.

Skin disorders

People who suffer from Xeroderma pigmentosum (XP), and some people with chronic actinic dermatitis (also known as chronic photosensitivity dermatitis) also have their conditions made worse by LED lighting.

Autistic Spectrum Condition

Many people on the autistic spectrum have sensory issues that can affect one or more of the senses that can be either over-developed (hypersensitive) or under-developed (hyposensitive). Both can affect how people experience environments. Fluorescent lighting has been shown to have a particularly negative affect on individuals on the autistic spectrum and flickering LED lighting can also be distressing. Sensitivity to light can manifest in different ways. Physical symptoms may include:

- lower tolerance for light
- discomfort from fluorescent, LED and other artificial light
- light avoidance behaviours (e.g. shielding eyes)
- afterimages
- visual snow
- headaches or migraine.

Other signs may include increased anxiety, repetitive behaviours as well as poor eye contact or eye movement. These types of sensory disruptions can lead to social problems and worsening educational outcomes, for school-aged people on the autistic spectrum.

Source: *LightAware*

It is difficult to estimate the number of people severely affected by LED street lights, but everyone is affected to some extent

72. Although LightAware has been contacted by many people who have been affected by LED street lighting, it is difficult to estimate how many people are affected by light-sensitivity. The reasons include: only a small minority of people with a problem may contact LightAware; people not being aware of what is causing their pain and discomfort; and people contacting other relevant charities, such as the Migraine Trust or Lupus UK or the National Autistic Society.
73. An estimate of the number of light sensitive people in the UK was made in 2012 by the Spectrum Alliance for light-sensitivity, a grouping of charities including Lupus UK, Eclipse Support Group, ElectroSensitivity UK (ES-UK), the XP Support Group, Lupus Europe, Migraine Action and supported by the National Autistic Society, Research Autism and Right to Light. Together they estimated the number of light sensitive people having health problems exacerbated by compact fluorescent lighting (CFL) and found that around 2 million people (3.25 per cent of the UK population) suffered adverse health effects. Although the number of people affected by LED lighting will be different, they are likely to be of a similar order of magnitude as the main drivers of light-sensitivity, such as flicker, glare and spectral effects are similar. However, further research is needed to quantify the number of people likely to be affected.
74. As well as light-sensitive people, many others will be affected by high blue-content LED lighting. Although the EU's SCHEER report concluded that 'There is no evidence that the general public is at a risk of direct adverse health effects from LEDs when the lights are in normal use', their media release neglected to mention that the definition of 'general public' excluded children, the elderly and light sensitive people, who were classed separately as 'vulnerable populations'.
75. The SCHEER report concluded under the heading 'vulnerable populations' that "*Children have a higher sensitivity to blue light and although emissions may not be harmful, blue LEDs may be very dazzling for young children. Older people may experience more problems with glare. Some people appear to be susceptible to flicker and many people experience the phantom array effects caused by flickering LEDs when they move their head or eyes.*" In addition to the 'vulnerable populations' above, as discussed earlier, blue rich LED street lights are a powerful disruptor of people's circadian rhythms which can cause disturbed sleep and a large number of other health impacts, creating a 'hierarchy of harm' (Exhibit 11).³⁶

They make my skin burn, make me feel queasy, cause an unsteady gait and my joints hurt.

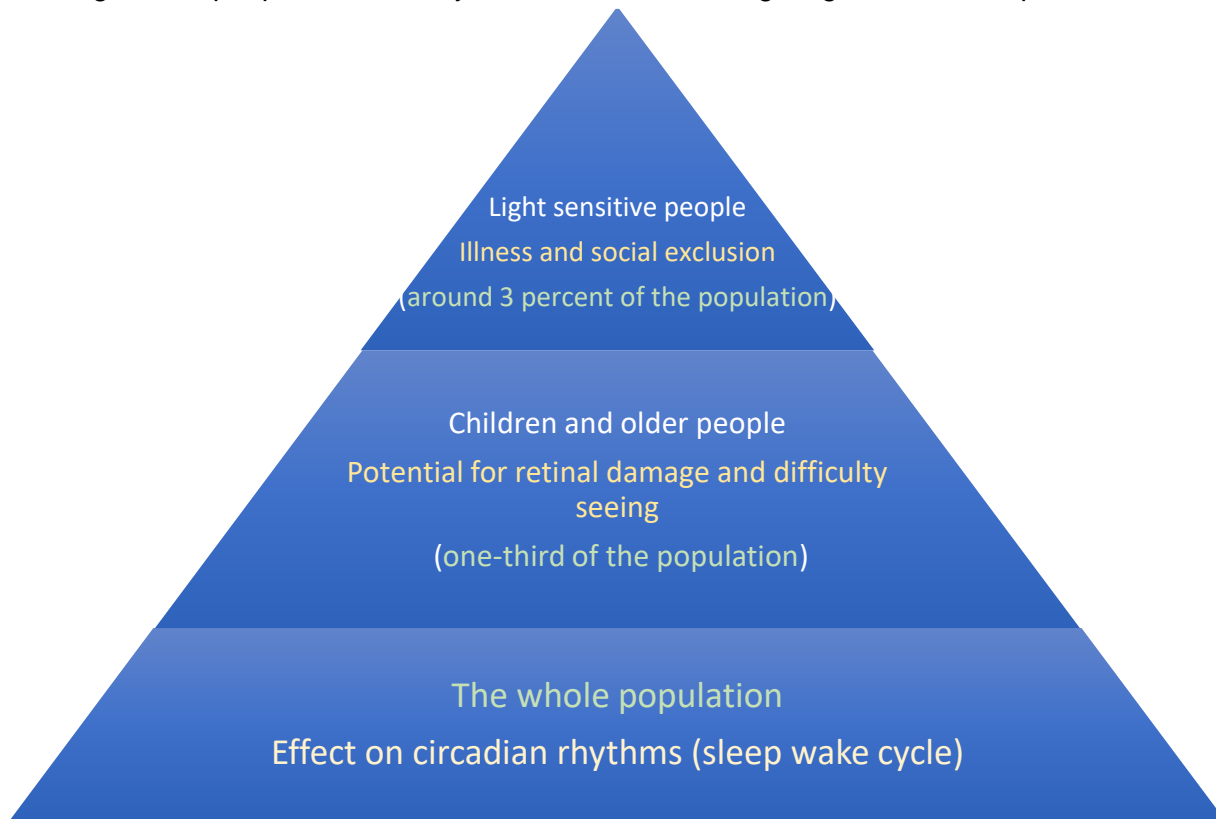
Jasmine, East Midlands

For me LED street lights trigger migraine. acute light-sensitivity, shock, and emotional distress. Emily, Lancashire

³⁶ Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), Opinion on Potential risks to human health of Light Emitting Diodes (LEDs), European Union, 2018.

Exhibit 11**The 'hierarchy of harm', high blue content LED street lighting has health impacts on us all**

Although some people are severely affected, LED street lighting has health impacts on us all.



Source: *LightAware, Spectrum Alliance*

Recommendations

- **Public Health England (and its successor body the National Institute for Health Protection) should support research to find out why LED street lighting is causing ill-health and set standards for external lighting to ensure that light-sensitive people can safely leave their homes at night.**

LED street lighting can have a detrimental effect on the environment

76. A central aim of the LED “lighting revolution” is decreased energy consumption. But this is being undermined by a rebound effect of its increased use in response to lowered cost of light, leading to increasing light pollution. Most of us are familiar with air, water, and land pollution, but artificial light at night is also a pollutant. The 2017 Annual Report of the Director of Public Health in England has included a section on how light pollution can have serious ecological consequences for humans, wildlife, and the climate.³⁷
77. To be effective, environmental policies and practices require a holistic multidisciplinary approach that considers the health, social, economic, and ecological impacts of the introduction of new technologies as well as their cost and carbon emissions.
78. There is an unfortunate history of well-meaning but ill-thought-out initiatives intended to reduce carbon emissions having unintended adverse consequences. For example, the EU’s efforts to promote biofuels as an alternative to fossil fuels has resulted in the destruction of rainforests to plant biofuel crops, in turn this has led to increased carbon emissions overall and the loss of habitat for threatened species. Current biofuel ambitions are likely to lead to a massive increase in demand for palm oil and soy, which would cause an estimated 7 million hectares of deforestation, including up to 3.6 m ha of peat drainage by 2030. Global CO₂ emissions from this additional deforestation are estimated to be 11.5 billion tons – more than China’s annual fossil fuels emissions from burning. In addition, although the climate change benefits of wind energy are enormous, wind turbines kill substantial numbers of birds and bats. When designing offshore and onshore wind farms it is important to maximize climate benefits while minimizing wildlife fatalities.^{38 39 40}
79. Only 22 per cent of councils undertook an Environmental Impact Assessment (Exhibit 3), therefore it is very likely that the introduction of LED street lighting will have had unintended environmental consequences, for example an increase in light pollution.

Light pollution is a major environmental issue

80. Artificial light pollution is an often-neglected environmental issue, despite a host of well-known negative effects. Natural light provides essential information for plants and

³⁷ Annual Report of the Director of Public Health in England 2017.

³⁸ See <https://www.rainforest-rescue.org/topics/biofuel>.

³⁹ Dramatic deforestation highlights EU ‘folly’ on biofuels, Transport and Environment, September 2016.

⁴⁰ Biofuels add fuel to forest fires. Rainforest foundation Norway, March 2020

animals so artificial night-time lighting has a broad range of impacts on both nocturnal and diurnal species. Lights at night can affect plant flowering times, birds and turtles can lose their way on migration, moths are attracted to light and can be eaten by bats and these changes lead to knock-on effects that can impact whole ecosystems.”

81. While research is continuing, it is becoming apparent that both bright days and dark nights are necessary to maintain healthy hormone production, cell function, and brain activity, as well as normal feeding, mating, and migratory behaviour for animals and birds. Light pollution drastically alters their night-time environment by turning night into day. This has had a dramatic impact on nocturnal ecology. For example, nocturnal animals sleep during the day and are active at night to enable them to avoid predators. Street lighting can affect this delicate predator /prey balance.

Because the lights make me so ill that I cannot go out after dark this means that, particularly in winter when nights are long, I am housebound for most of every day. This means no social life, no ability to go for a walk in the evening or early
**Jane,
North-East England**

82. All bats, their resting and breeding sites are protected in Europe under the European Habitats Directive. It is an offence to disturb a bat deliberately, where disturbance is defined as anything that impairs a bat’s ability to survive, breed or reproduce, or significantly affect the local distribution or abundance of a species. Disturbance caused by artificial lighting could constitute an offence under European law and therefore must be considered by councils during Environmental Impact Assessments. ⁴¹

83. Exeter scientists have said that research is urgently needed to understand how best to prevent unforeseen ecological effects. “We are making fundamental changes to the way we light the night-time environment, with potentially profound consequences for a range of species,” said Dr Thomas Davies, of the Environment and Sustainability Institute at the University of Exeter. ⁴²

84. The main types of light pollution include:

- Sky Luminance – this occurs when upward light is diffused through clouds, mists, and airborne particles in the atmosphere.
- Sky Aura - is related to lighting effects caused by light reflection from areas local to the lighting installation - a particular issue with LED street lighting.
- Urban Sky Glow - the brightening of the night sky over inhabited areas.

85. LED street lighting can cause light pollution via direct emission, scattering and reflection. However, most modern streetlights restrict all upward light emission, so that the greatest component of street lighting pollution arises from ground reflection. This depends on the type of ground cover (and can be greatly increased by snow cover in winter). Although

⁴¹ Conservation of Natural Habitats of Wild Flora and Fauna 1992/42/EEC). regulation 41.

⁴² http://www.exeter.ac.uk/news/research/title_757241_en.html

LED street lighting can be effectively directed at the ground, the high blue content of current LED street lighting is unfortunately more prone to reflection and scattering.

86. The bluest sources, such as 4000k and above streetlights, produce 15 to 20 per cent more radiant sky glow than high pressure sodium (HPS or low-pressure sodium (LPS). This effect is compounded for visual observation (as practiced by casual stargazers and amateur astronomers) by the shift of dark-adapted human vision toward increased sensitivity to shorter wavelengths. In a relatively dark suburban or rural area, where the eyes can become completely or nearly completely dark-adapted, the brightness of the sky glow produced by artificial lighting can appear 3–5 times brighter for blue-rich light sources as compared to HPS and up to 15 times as bright as compared to LPS.⁴³
87. However, street lighting is not the only cause of sky glow, the reduction in the cost of LED lighting has led to increased use of LED lighting for other external uses such as security lighting, street signs, floodlighting at sports and leisure facilities, decorative lighting, advertising lighting and the illumination of historic buildings, and lighting in greenhouses to extend the growing season. In addition, it is becoming common to use LED lighting in parks during the winter and in some parts of the UK even forest trails have been subjected to LED illumination. All of these contribute to light pollution and to the social exclusion of light sensitive people.

Dark skies

88. Our spectacular universe of planets stars, galaxies and the Milky Way has been visible in the night sky for most of human history. But light pollution has obliterated the stars across much of the UK, with only a few of the brightest stars now visible and many people living in urban areas have never seen the Milky Way.
89. In 2010, the Council for the Protection of Rural England and the British Astronomical Association's Commission for Dark Skies ran a survey to find out how people's lives are affected by light pollution. The survey revealed that the main causes of light nuisance are road lighting (89 per cent), domestic security lighting (79 per cent), streetlights that are more than five years old (77 per cent) together with businesses, sports grounds, and supermarkets, 82 per cent of respondents said that the offending lights were left on all night. They also produce a detailed interactive map of light pollution across the UK. ^{44 45}
90. The International Dark-Sky Association advocates that any required lighting be used wisely. To minimize the harmful effects of light pollution, lighting should:
- only be on when needed
 - only light the area that needs it

⁴³ International Dark-Sky Association, Visibility, Environmental, and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting, May 2010.

⁴⁴ Night Blight: Mapping England's light pollution and dark skies, Campaign to protect rural England.

⁴⁵ <https://www.nightblight.cpre.org.uk/maps/>

- be no brighter than necessary
- minimize blue light emissions
- be fully shielded (pointing downward).

91. The UK's All Party Parliamentary Group on Dark Skies produced a policy document in 2020, listing actions needed to "reverse the exponential growth of environmental pollution caused by artificial light." Among these are:

- Set standards for the brightness and colour temperature of lighting: establish legal limits to the amount of blue light that luminaires can have in their spectrum and encourage manufacturers, distributors and installers of lighting to adopt best practice in this area.
- Create 'best practice' use for lighting: design a national program of best practice 'Dark Sky Hours' in which categories of lighting can be either dimmed or turned off completely in consultation with the community, lighting professionals and local police.⁴⁶

92. It would be helpful if councils followed these guidelines.

Recommendations

- **Councils should undertake a thorough Environmental Impact Assessment to ensure LED streetlights are not causing ecological damage. This assessment should be part of a holistic multidisciplinary approach that considers the health, social, economic, and ecological impacts of the introduction of new technologies. It should take steps to protect all rare bird mammal, insect, and plant species within its area.**
- **Councils should consider the impact of Light Pollution as part of their planning system to ensure that new developments and building projects minimise light pollution to protect the environment and the health of their inhabitants.**
- **Councils should, as far as possible, minimise light pollution in their areas and ensure that designated dark skies areas are supported. This could include encouraging the creation of 'Dark Skies' areas by having referendums in rural areas as to whether to have street lighting at all or to switch off street lighting after a particular time.**

⁴⁶ <https://www.darksky.org/our-work/lighting/lighting-for-citizens/lighting-basics/>

Appendix 1 Light sensitive individuals' experiences of LED street lighting

A number of people have contacted LightAware about their problems caused when LED street lighting was introduced in their area. We asked them to describe their experiences by asking:

- What effects do LED street lights have on you?
- Are any street lights better or worse?
- What have you done to avoid these effects?
- How has this affected your life?

Their comments are included in full and unaltered below. We have changed their names to preserve their privacy. The LightAware website also contains a number of case studies of how people's lives have been affected new lighting technology (see <https://lightaware.org/2018/03/9-lightaware-case-studies/>).

What effects do LED street lights have on you?

The intense whiteness and glare from many LED street lights make me feel immediate pain and discomfort and after a while I feel sick and get headaches, I also find it very difficult to get off to sleep and I often lay awake all night if I have been exposed to LED lights.

Tom, Manchester

Migraine, burning red rash, nausea, circulation slowing so cold, followed by fatigue, joint pain.

Elizabeth, Southern England

They make me feel sad and gloomy when out at night, some very bright ones make me feel sick and dizzy and 'flinchy'.

Angela, Central Scotland

All new street lights, including LEDs, make me feel disorientated, lose my balance and be unable to sense my feet. On the few occasions I have been under them I have to hold onto another person to stop myself falling. After being exposed I suffer a migraine.

Jane, North-East England

I am extremely affected by the light flickering of LED streetlamps. The provocation of my nystagmus (eye movement disorder) by alternating light stimuli significantly disturbs my vision as well as my orientation and, in addition, leads to violent health reactions in case of an "overdose". A stressful over-stimulation of my physiological perception is usually

followed by dizziness, nausea, whole-body trembling, dazedness, booming noises in the ear, severe eye pain with redness, stabbing headaches, up to migraine and fever with cold sweat. Loss of vision also occurs. After such a reaction to flickering light, I need about two to three days to recover if I am in good health.

Michael, Germany

Most LED Street lighting makes me feel really awful and unable to function well, with migraines, dizziness, pain, extreme discomfort, being on edge, and a substantial general feeling of malaise. Non-LED street lights are totally fine for me!

Gordon, Oxfordshire

They cause my heart to race, make me feel nauseated, dizzy, disorientated, make my skin hot and inflamed and cause my nerves to become heightened in my skin and immense itching which also affects my sleep. Exposure to artificial lighting can cause my Lupus to flare. **Jennifer, East Midlands**

Eye strain and headaches

Alan, London

Some lights are better than others but the bad ones give me a terrible headache and nausea that kicks in after 2- or 3-minutes exposure and takes a week to go away. The symptoms are like recovering from gastroenteritis and I am unable to socialise or leave the house for a week until they go away.

Julia, Cambridgeshire

They make my skin burn, make me feel queasy, cause an unsteady gait and my joints hurt.

Jasmine, East Midlands

For me LED street lights trigger migraine. acute light-sensitivity, shock, and emotional distress. **Emily, Lancashire**

Are any street lights better or worse?

Some do appear to be better than others though I am not an expert it is clearly unnatural to have a daylight white type light at night. I feel that if the glare was much less and controlled by better diffused and shading so you could not see the emitter in your field of view as well as being a much more orange colour that would help and improve conventional road safety as I know of at least one traffic accidents caused by streetlight glare. I believe many flicker at a high frequency that may be part of the problem for me and understand that this flicker is completely avoidable. I had no issues with incandescent, halogen, CFL or sodium lighting so they are clearly issue with LED technology that are not fully understood and controlled.

Tom, Manchester

None as good as old sodium halide. But with LEDs the cooler the colour temperature the worse the effect.

Elizabeth, Southern England

Bright blue/white ones are much worse.

Angela, Central Scotland

I don't know because street lights in my area/street were changed over 4 years ago from sodium halide. Their effect on me was so devastating I have barely left the house or even opened my front door in the evening since they were installed. I can also be affected during the day as many LEDs are actually on permanently, presumably because they are defective or have light-sensitivity settings that are inappropriate.

Jane, North-East England

I didn't have these problems with the sodium vapour lamps. But the old mercury vapour lamps are also terrible.

Michael, Germany

All LED Street lighting makes me feel awful and ill, weather cool or warm white. It's all way too harsh and intense.

Gordon, Oxfordshire

No.

Jennifer, East Midlands

About the same as I avoid them where possible and fortunately, I still have sodium on my street so it hasn't impacted my home life. However, if they were installed in my street I would likely have to move.

Alan, London

The ones in my street are not good but there are not many of them so mostly the street is in darkness, which is actually better. The ones in Jesus Green are just awful though and have the effect that I described in question 1 (They give me a terrible headache and nausea that kicks in after 2- or 3-minutes exposure and takes a week to go away). If I want to cycle across the park after dark, I have to cycle in the dark across the grass well away from the lights, which is a great personal safety risk, quite apart from the risk of my bike hitting a deep ditch and flipping me off. **Julia, Cambridgeshire**

No

Jasmine, East Midlands

In Lancashire where I live, the council have installed Urbis Schreder Teceo street lighting on the main roads. These are the worst LED street lights I have ever encountered. It takes me three weeks of extreme pain and distress to recover from even a short exposure to these lights. They are like a blue floodlight. The LED street lights on the side streets are lower in height and less glaring. Direct exposure to one of these will give me a shorter migraine event, between 3 days and a week. Either way, after the headache subsides, for some time I find I am still much more sensitive to LED and other bright lights than normal, and this means that I can end up ill for months as migraine is triggered repeatedly. This has happened for several years at the time the clocks go back and lighting gets harder to avoid.

Emily, Lancashire

What have you done to avoid these effects?

I have to avoid being exposed to light from the LED street lights if at all possible. I can no longer drive or go out on foot at night at all. I have had extensive consultations with ophthalmologists and neurologist and I have nothing fundamentally wrong with me though the effects of many LED light on me are clear and life limiting.

Tom, Manchester

As in the day UV proof mask and clothing and amber glasses and wide brimmed hats, but avoidance whenever possible.

Elizabeth, Southern England

I avoid certain streets and town centres, choose who I visit by what their street lights are.

Angela, Central Scotland

I do not leave my house or open the front door to callers when the street lights are on. In winter this is particularly isolating. It is very difficult to avoid the lights that are on during the day.

Jane, North-East England

Before the LED street lights come on in the evening, I need to be safe at home to avoid eye and headaches, vegetative disorders, accidents, and injuries.

If, on the other hand, the LED street lights are switched on during the day when it is cloudy or raining, I have to cancel appointments (e.g. a medical examination) if no one can accompany me safely.

Michael, Germany

I generally have to avoid driving and walking outside when the LED lights are on to avoid ill symptoms.

Gordon, Oxfordshire

I avoid going out during times when streetlamps are lit. I have had my car windows fitted with UV filter film and on occasions I am accompanied I travel in the back of the car.

Jennifer, East Midlands

Lobbied council to ensure my street maintained safe sodium streets lights. Wear a baseball cap to cut out the light. Avoid walking at night or standing under these lights.

Alan, London

I no longer cycle or walk in the streets after dark.

Julia, Cambridgeshire

I don't go out and expose myself to the street lighting

Jasmine, East Midlands

I made the decision several years ago, that I would simply no longer leave the house after dark. This practically means making sure I am home by 2.30pm in midwinter. At the time of writing, my immediate area is still lit by sodium street lights. On the rare occasions I do go

out of my area after dark, I have to get a taxi and cover my eyes with a tight scarf so that no light enters. This makes me feel vulnerable, and it is not fool proof. Staying in seems the best policy.

Emily, Lancashire

How has this affected your life?

I was already unable to work due to LED lighting in offices but losing the freedom to be outside or even look outside at dawn and dusk is a further disability I am having inflicted upon me. The winter months are a particularly difficult time as I have to draw the blinds and curtains in the middle of the afternoon to avoid feeling ill.

Tom, Manchester

Stay at home more. I have to avoid sunlight but bright/cool white LEDs worse than sunlight, night where there are street lights worse than day.

Elizabeth, Southern England

I don't often go out after dark unless I know there's a 'safe route' through ok lighting. This affects my work and social life and that of my family.

Angela, Central Scotland

Because the lights make me so ill that I cannot go out after dark this means that, particularly in winter when nights are long, I am housebound for most of every day. This means no social life, no ability to go for a walk in the evening or early morning. If a family member had an emergency, I would not be able to drive them to a hospital. More trivially, I can't answer the door to local children doing trick or treat and I feel it makes me seem very miserly.

Jane, North-East England

So far, the flickering LED vehicle lighting has had a massive impact on me. The widespread conversion to LED street lights has now further limited my radius of action.

Michael, Germany

Profoundly! I am now cut out of life! For example, during my wife's year of battling against cancer, I wasn't able to drive or accompany her to many of her hospital appointments especially during the darker winter months because of the new LED lighting. I had to find members of the community to do this for me instead. It also means I am not able to go out to work or help with family shopping anymore!

Gordon, Oxfordshire

My quality of life is impacted greatly due to me being unable to go anywhere when streetlamps are lit. I can only go out during daytime hours which restricts any social or practical daily living events. I am unable to give lifts to my children outside of daytime hours, my friends and family are very understanding but have to work around my needs.

Jennifer, East Midlands

Restricts my mobility at night.

Alan, London

My life is very constrained anyway because I can no longer visit any public buildings, shops, libraries, churches, or schools because of the lighting. Until recently I could at least enjoy the outdoors, but that is becoming increasingly tricky as the outdoor lights are changed over and driving me indoors.

Julia, Cambridgeshire

Any essential journeys need to be done during daylight hours which restricts my ability to go out during the evening to undertake normal activities of daily living. My life has been restricted significantly and has increased the sense of isolation.

Jasmine, East Midlands

This has been a devastating change in my life, it means I am excluded from work or leisure outside the house, things like visiting friends, going to classes or meetings, or even just walking through town are impossible, as is teaching in the homes of my students which is something I can do in the summer. It has been a huge adjustment, and very upsetting, but it is so much better than living with constant pain which was what was happening in winter before. And I have learned to appreciate the rhythm of the year much more now that I effectively hibernate.

Emily, Lancashire

If you have contacted your local council about LED street lights, what type of response have you received?

I engaged with my council and after initially being fobbed off they accepted there were health problems and offered to make some changes locally to help me they changed the 4000k LEDs in my village for constant current, 3000k, with better quality diffusers and some with directional shields to reduce glare towards my property. The changes helped it that I can now go out at night to for example put the bins out but I still need to wear sunglasses and would try to avoid going out as this gives me the best of getting a good night's sleep. I appreciate the council did try to help me but the wider issue is that something on a national or global scale needs to be done there are clearly issues with LED technology that are not understood and the constant drive to save energy has meant common sense has gone out of the window as with any new technology history has taught us a cautious approach is needed; let's not have another asbestos.

Tom, Manchester

No. We were lucky to live in a country lane with no street lights, we now live in a private close with no street lights. Have helped others to write to the council with mixed results.

Elizabeth, Southern England

I haven't yet!

Angela, Central Scotland

When it was proposed to introduce LEDs on our local promenade (I live on the coast), there was a public meeting to discuss the proposals. I was unable to attend but a friend explained about the likely adverse health effects on some residents and that lights were in any case not necessary on the prom. He was told by the elected mayor that everyone wants these lights. In other words, the possibility of anyone becoming ill was deemed to be irrelevant, so they were installed.

Jane, North-East England

My request has been examined by the city council. The final report expressed regret for my situation. However, as the city identifies itself as a consumer in the report, my intolerance to flickering lighting in barrier-free building projects cannot be taken into account. After all, the city has to take what the lighting market offers. The priority here is to save costs - not the welfare of the citizens.

Michael, Germany

After years of lobbying my council, they have switched some of the LED street lighting on my street back to amber sodium lights. But there's no guarantee that they will continue to do so and it hardly helps that LED lights are now almost everywhere!

Gordon, Oxfordshire

Our village is in the process of changing the streetlamps to LED. The Parish Council has agreed not to change the lamp in the road where I live and plan to keep the 'old' bulbs from the lamps being changed so that there are spare supplies for the one in my road.

Jennifer, East Midlands

As above the only concession was to maintain sodium in my street but this could be time limited as we don't know when suppliers will phase out. They've installed LED in most other parts of the borough so makes it difficult and forces me to wear hats/avoid prolonged periods walking most streets in my areas.

Alan, London

I contacted the council and they told me that the person in charge of street lighting safety had left.

Julia, Cambridgeshire

I have been in very regular contact with my council for the last 8 years. They have been supportive. After long and in-depth communications and me submitting medical evidence they have agreed to keep the sodium lighting in my street and a few surrounding streets so that at least I don't have LED street lights shining into my house. They have made a commitment to keep my streets as sodium for the meantime at least. They have not been open to reconsidering the roll out of LED street lighting in general, but we are in negotiation about the roll out in my area, and they are trialling some more orange coloured LED street lights to see if they are acceptable to me.

Emily, Lancashire

Appendix 2: LightAware freedom of information request

Part 1 The introduction of LED Street lighting and Health and other assessments

Please supply LightAware with the following information

<p>1) Introduction of LED street lighting</p> <p>a) Has your council introduced any LED street lighting over the past 5 years? If yes please explain why it was introduced.</p> <p>b) Were residents consulted before the LED street lighting was introduced? If yes, please supply us with copies of all reports on the consultation and associated papers?</p> <p>c) Did the council pilot the introduction of LED street lighting in any areas? If yes, please supply us with a copy of the evaluation of the pilot sites.</p> <p>d) Has the council had complaints about LED street lighting? If so, please let us know the number of complaints each year, and a breakdown of the reasons for the complaints, if available.</p>	<p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p>
<p>2) Health and other assessments</p> <p>a) Did the council conduct research into the safety and user acceptability of LED street lighting?</p> <p>b) Did the council undertake a health impact assessment prior to introducing LED street lighting?</p> <p>c) Did the council undertake a disability impact assessment prior to introducing LED street lighting?</p> <p>d) Did the council carry out an Equality Impact Assessment, for example to ensure that older people are not disadvantaged by such lighting?</p> <p>e) How did the council ensure that the introduction of LED street lighting met its obligations under the Public Sector Equality Duty (PSED) to ensure that it did not cause discrimination?</p> <p>f) Did the council carry out an EIA (Environmental Impact Assessment)?</p> <p>g) Did the council assess the impact on protected species (e.g. bats) and what steps (if any) were taken to ensure that the chosen LED specification satisfied the statutory duties relating to biodiversity. If yes please supply LightAware copies of relevant documentation.</p> <p>h) How does the council take into account the sensitivities of residents with sensitivities to LED street lighting, e.g. people suffering from migraines, lupus, and autism? Please describe the process.</p> <p>If the answer is yes to any of the questions a) to g), please supply a copy of the relevant council papers and assessments.</p>	<p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p> <p>Yes/no</p>

Part 2 Investment in LED street lighting

<p>3) How much has the council invested in LED street lighting in each of the past five financial years?</p>	<p>2014/15 2015/16 2016/17 2017/18 (for 2017/18 provisional figures if appropriate)</p>
<p>4) How was the LED street lighting funded in 2017/18?</p> <ol style="list-style-type: none"> 1) Green investment bank? 2) Public works loan board? 3) Prudential borrowing? 4) Revenue to capital? 5) Other (please specify? 	<p>Please indicate funding from each source</p>
<p>5) How many street lights in the current council area are currently (as of 30 June 2019)?</p> <ul style="list-style-type: none"> • Low Pressure Sodium discharge lamps • The high-pressure sodium lamps • Metal Halide • LED • Other please specify 	<p>Number of each</p>
<p>6) Of the LED street lights how many are:</p> <ul style="list-style-type: none"> • Phosphor-Converted Amber (PCA) LED Street Lamps? • Narrow-Band Amber (NBA) LED Street Lamps? 	<p>Number of each</p>
<p>7) Colour temperature of LED street lighting. Of the currently installed street lighting please let us know the number in the following correlated colour temperature categories:</p> <ul style="list-style-type: none"> • Under 3000 degrees kelvin • 3000 – 3999 degrees kelvin • 4000 degrees kelvin and higher 	<p>Number of each</p>
<p>8) Glare and flicker - What steps (if any) the authority has taken to mitigate the known and serious problems (relating to health and road and public safety) of glare and flicker that are associated with LED street lighting.</p> <ul style="list-style-type: none"> • How many of the installed LED street lights are flicker free? • How does the council monitor that they remain flicker free? • How many of the installed LED street lights have unshielded LED chips? 	<p>Number of each</p>

Part 3 Planned investment in LED street lighting

<p>9) How much has/ does the council plan to invest in LED street lighting in each of the following financial years?</p> <ul style="list-style-type: none"> • 2018/19 • 2019/20 • 2020/21 	<p>(£)</p>
<p>10) How does the council plan to fund this investment?</p> <ul style="list-style-type: none"> • Green investment bank? • Public works loan board? • Prudential borrowing? • Revenue to capital? • Other (please specify?) 	<p>£ from each source</p>
<p>11) Of the current street lights in your council area (see question 5), how many do you plan to replace over the next 3 years?</p> <ul style="list-style-type: none"> • Low Pressure Sodium discharge lamps • The high-pressure sodium lamps • Metal Halide • LED • Other please specify 	<p>Number of lamps</p>
<p>12) What do you plan to replace them with? If the replacements are LED let us know the number in the following colour temperature categories:</p> <ul style="list-style-type: none"> • Under 3000 degrees kelvin • 3000 – 3999 degrees kelvin • 4000 degrees kelvin and higher 	<p>Number of lamps</p>
<p>13) 1) In undertaking this investment has the council taken into account recent reports on the health and safety of LED lighting produced by:</p> <ul style="list-style-type: none"> • The EU SCHHER report on potential risks to human health of Light Emitting Diodes (LEDs)? see link https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_o_011.pdf • The latest EU guidance on the procurement of LED street lighting? see link https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/revision-eu-green-public-procurement-criteria-road-lighting-and-traffic-signals • The French public health institute (ANSES) report on effects on human health and the environment (fauna and flora) of systems using light-emitting diodes (LEDs)? see link https://www.anses.fr/en/system/files/AP2014SA0253EN.pdf 	<p>yes/no</p> <p>yes/no</p> <p>yes/no</p>