LightAware response to Ecodesign consultation

Our responses to the individual questions put by BEIS are below. We also include a copy of our report into the introduction of LED street lighting, which illustrates in detail some of the pitfalls in pursuing financial savings and carbon reductions without fully considering human health and impacts on the ecology of the natural world.

Q.1 Do you agree with our intention to introduce the new ecodesign requirements for lighting products in GB, as set out in the draft Regulations (reflecting what the UK agreed at EU level as a Member State in December 2018)? If you do not agree, please provide reasons supported by evidence where possible.

While we agree with the intention to introduce the new ecodesign requirements, LightAware believes that efficiency targets for lighting should be considered differently from legislation that sets standards electrical products such as refrigerators and toasters. Because lighting has such a profound impact on human health and on the ecosystems, while most other items of electrical equipment do not. More research needs to be undertaken into the long-term effects on human health of LED lighting. So far, the research that has been undertaken, for example the ANSES report by the French Government, has indicated that there are long-term negative impacts that the UK Government should be very wary about.

In particular, the proposals only consider the economy and efficiency of new forms of lighting, but omit consideration of its effectiveness, both in terms of their usefulness for human vision and their impact on human health and wellbeing. These are discussed in our response, but also form a key part of our report on LED street lighting, planned for publication later this month. Our report demonstrates the pitfalls of seeking to maximise efficiency in terms of financial and energy savings without considering the overall impact on health and the natural world. Our report illustrates the pitfalls of taking such a narrow view when making decisions about lighting.

To be effective, ecodesign policies for lighting require a holistic multidisciplinary approach that considers its health, social, economic, public safety, and ecological impacts. So far, the introduction of LED lighting has been driven by financial savings and carbon reduction targets without regard to its wider impacts. We believe it is time to remedy this state of affairs.

Another key issue that has not yet been considered is that the reduction in price of light as a commodity has led to increased use. The cost of light has fallen sharply and has resulted in increased night-time illumination and light pollution, which is increasing at two per-cent per year and has become a major ecological challenge.[1] The Annual Report of the Director of Public Health in England has included a section on how light

[1] 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.

pollution can have serious environmental consequences for humans, wildlife, and the climate.[2]

Without additional measures, the efficiencies sought under ecodesign requirements prove illusory as the reduced cost of light leads to increased use and increased light pollution and CO2 emissions. As an example of unintended consequences it might be useful to consider the EU's efforts to promote biofuels as an alternative to fossil fuels. Unfortunately, this has resulted in the destruction of rainforests to plant biofuel crops, which in turn led to increased carbon emissions estimated to be 11.5 billion tonnes.[3] [4] [5]

Q.2 Do you agree with our intention to introduce the new energy labelling requirements for lighting products in GB, as set out in the draft Regulations (reflecting what the UK agreed at EU level as a Member State in December 2018)? If you do not agree, please provide reasons supported by evidence where possible.

Yes, but LightAware believes that the health and ecological impacts of LEDs should be taken into account and that over time changes should be considered to minimise negative impacts.

Q.3 Do you agree with our intention to implement the proposed GB ecodesign and energy labelling requirements for lighting products from 1 September 2021?

Yes, but LightAware believes that a literature survey of the health and ecological impacts should be undertaken and, if necessary, research, should be commissioned to minimise any negative impacts.

Q.4 Do you agree that this implementation date (1 September 2021) is achievable for SMEs (Small and Medium Enterprises, i.e. businesses with fewer than 250 employees)? If you do not agree, what support or allowances could be given to small and micro businesses to help them meet this implementation date, or what transitional period should be allowed?

Yes, LightAware believes that the implementation date is achievable.

Q.6 Do you agree with our assessment of the benefits of introducing these GB ecodesign and energy labelling requirements for lighting products?

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[2] Annual Report of the Director of Public Health in England 2017.

[3] See https://www.rainforest-rescue.org/topics/biofuel.

[4] Dramatic deforestation highlights EU 'folly' on biofuels, Transport and Environment, September 2016.

[5] Biofuels add fuel to forest fires. Rainforest foundation Norway, March 2020

Partially, but your assessment does not undertake any calculation of the elasticity of demand for lighting as a commodity as its price falls referred to in our response to question 1. This is likely to lead to an over-estimate of financial savings (and reduction in carbon emissions. In addition, the 'real' carbon savings achieved by the GB ecodesign and energy labelling requirements will fall as the proportion of electricity generated from renewables rises. We would suggest that the UK government refines these calculations to ensure that decision making is informed by realistic estimates of potential savings.

Q.7 Have the costs, in general, to UK businesses of introducing these GB ecodesign and energy labelling regulations for lighting products been assessed adequately?

This is beyond LightAware's competence to respond.

Q.8 What investment of resource, whether monetary costs or staff hours, do you estimate would be needed to prepare for the introduction of the new ecodesign and energy labelling requirements (for example, in order to familiarise with the legislation)? Are there any other costs that would result from the transition to the new requirements? Please specify.

This is beyond LightAware's competence to respond.

Q.9 Do you agree with our assessment of the impact of not introducing these GB ecodesign and energy labelling requirements for lighting products? Have any impacts of not introducing these requirements been overlooked?

This is beyond LightAware's competence to respond.

Q.10 Can you provide any evidence in relation to the size of the manufacturing base for lighting products in the UK? What proportion of UK-based manufacturers are SMEs (Small or Medium Enterprises, defined as businesses with fewer than 250 employees)? Please provide evidence where possible.

This is beyond LightAware's competence to respond.

Q.11 Can you provide evidence as to whether any UK-based SMEs may be forced to exit the market due to potentially high barriers to operating as a result of implementing these requirements for lighting products in GB?

This is beyond LightAware's competence to respond.

Q.12 What would be the impacts on SMEs in particular if the new ecodesign and energy labelling requirements were implemented in GB? Thinking back to your answer to Q.8, are SMEs affected differently or disproportionately by the costs you described here? Ecodesign and energy labelling for lighting products: consultation 22

This is beyond LightAware's competence to respond.

Q.13 To what extent would stakeholders plan to align with EU standards for lighting products in the absence of GB-specific regulation?

We believe that there is an opportunity for GB to better align lighting standards with the needs of businesses, employees, and UK residents by encouraging the use of more human and ecologically friendly lighting.

Q.14 Would there be any impact on imports/exports of lighting products from/ to the EU in the absence of GB-specific regulation?

This is beyond LightAware's competence to respond.

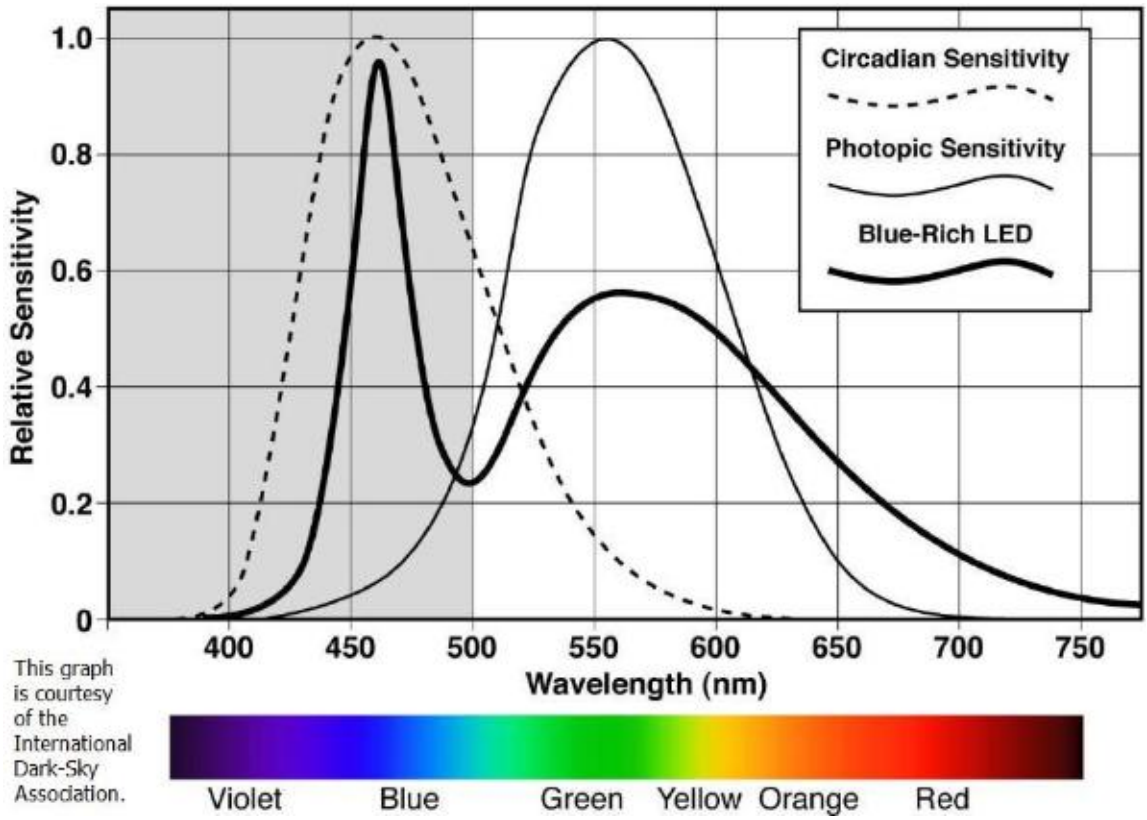
Q.15 What impact would maintaining consistency with the EU's 2021 requirements have on innovation in lighting products in GB? Can you provide any quantitative evidence on the rate of innovation within GB and worldwide markets for lighting products?

This is beyond LightAware's competence to respond.

Q. 16a Could the minimum energy performance standard for all light sources be set to 120 lumens/watt from 2023 and then raised to 140 lumens/watt from 2025 in the UK? Please provide a reason for your answer.

LightAware believes lumens per watt is a very poor measure of energy performance as indicated in the exhibit below. This is because it is only a measure of the output of the LED but does not indicate whether the light produced is useful in terms of human vision or measure its health impact. In particular, blue rich LEDs tend to be the most efficient using this measure but have a peak at the wavelength that maximally effects human circadian rhythms but is much less usable for human vision than those at a lower colour temperature. (See exhibit below).

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



Source: International Dark Sky Association.

Another reason lumen per watt is a poor measure of the performance of LEDs is that light is not distributed evenly across its beam but concentrated on the axis. This causes problems of glare, for example, LED 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.

LightAware are particularly concerned that measures to increase 'efficiency' will lead to increased problems, including:

- 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.

Some of the challenges are set out in "Measuring and using light in the melanopsin age" Lucas, Peirson, Berson et al: Tends in Neuroscience Vol37, Issue 1 Jan 2014 pages 1-93.

Q.16b What would be the impact on businesses and consumers? Please provide evidence and/or data.

The major issues associated with LED lighting are risks to the health of light sensitive individuals. The main health risks 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.

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

High luminance LEDs can cause problems with glare

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 LEDs for example streetlights, cycle lights and mobile phones have their LED chips visible, which can form 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 when a car with LED headlights comes over the brow of a hill or goes over a speed bump. [6]
- **Discomfort glare** causes irritation or anxiety and causes visual fatigue and eyestrain and can adversely affect wellbeing [7] Depending on an individual's sensitivity it can cause dry or watery eyes; itchiness; tense muscles; breakdown of vision, blurred or double vision; headaches or fatigue.

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 very dazzling and more so for young children (who have higher transmission of light through to the retina) and older people (who will suffer from scattering of the light, particularly in the lens of the eye). This means that 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.

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[6] The Lighting Handbook. London, Society of Light and Lighting, 2009.

[7] 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.

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

LED lighting is an inherently a bright point source and can cause eye fatigue and if it directly shines into people's eyes, they cause the pupil of the eye to become smaller leading to worse night-time vision, defeating the purpose of street lighting, 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" or dementor lighting.

LED flicker can cause migraines and also presents a safety hazard

The nature of the light LEDs produce depends on the circuitry within the lamp. This converts 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.

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

Flicker can also disrupt the movement control of the eyes and force the brain to work harder, causing discomfort and migraine in some people. 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.

LEDs can cause disturbed sleep

A core health concern about LED lighting and street lighting in particular, 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 abates.

In the early 2000s a 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 more sensitive to evening light than previously thought and that there are also substantial differences between individuals in light sensitivity.[8] [9]

Unfortunately. Blue rich LED lighting has 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 or incandescent bulb.

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.

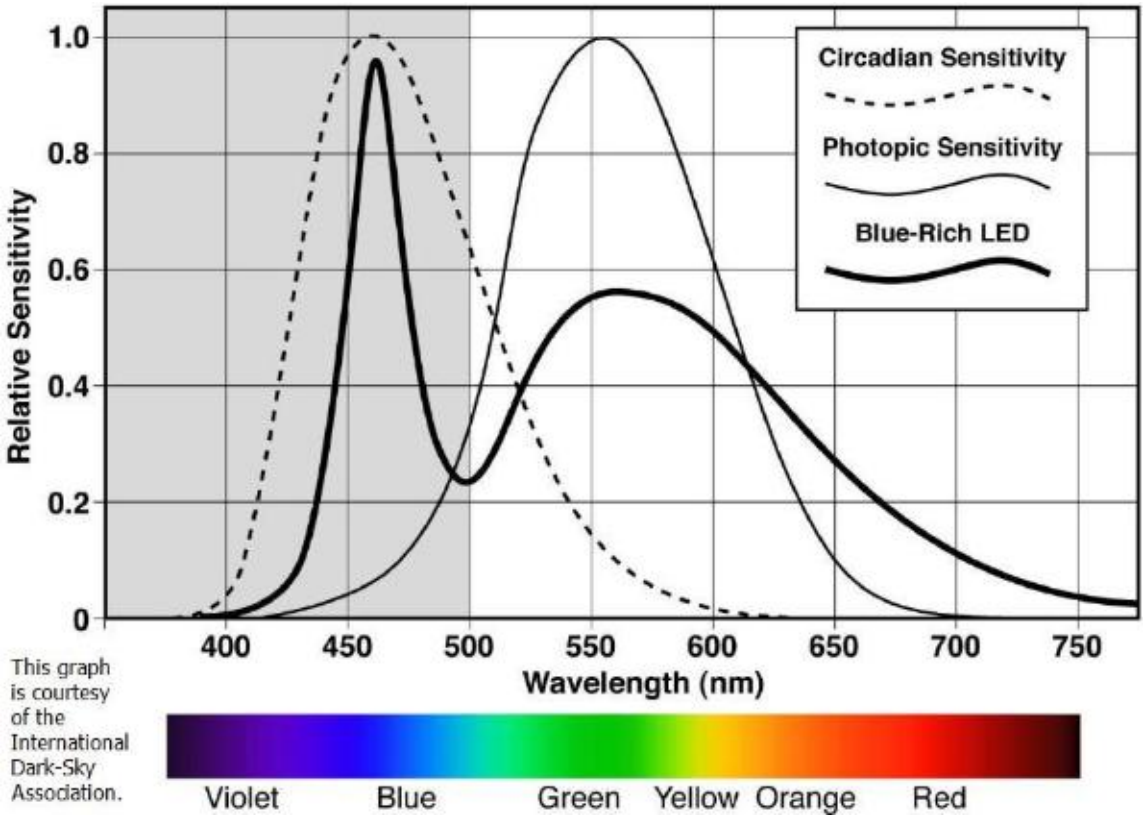
The human eye is not equally sensitive to all wavelengths in normal daylight vision, known as photopic vision, the eye has a peak sensitivity at 555 nanometres (green). LED streetlights producing a peak of blue light, which is the hardest colour to see A lot of the blue light produced by LEDs is not useful for human vision which may partially account for the comments about prison/dementor lighting (although it can be useful for CCTV cameras).

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.

[8] 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).

[9] 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).



Source: International Dark Sky Association.

LED lighting exacerbates a number of light sensitive illnesses – the current consultation document only mentions migraine as a problem.

As well as these effects on the population as a whole discussed above, a number of people suffer from various types of light sensitivity that are exacerbated by LED lighting. A number of people suffering from these illnesses have got in touch with LightAware for advice as to what to do about their problems with LEDs.

Migraine

Light-sensitivity is so common in people with migraine that it is itself a diagnostic criterion. 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%) light sensitivity is intricately linked to their condition.

LED bulbs are capable of inducing feelings of dizziness and pain within 20 minutes of switching them on. In particular, LED lighting may have greater fluctuations than traditional light sources, LED lighting effectively switches on and off hundreds of times every second. In addition, 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 have lupus and it is more common in women than in men. Up to 70 per cent of people with lupus have some skin symptoms and 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. This means that Lupus sufferers who cannot go out in sunlight can be effectively trapped in their homes at night.

People who suffer from light Xeroderma pigmentosum (XP), Chronic actinic dermatitis (also known as Chronic photosensitivity dermatitis) also have their conditions made worse by LED lighting.

Autistic spectrum disorders, including Asperger's

Many autistic people 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 have an affect how people experience environments. Fluorescent lighting has been shown to have a particularly negative affect on individuals with autism and flickering LED lighting can also be distressing. Sensitivity to light can manifest in different ways for people with autism. Physical symptoms may include:

1. lower tolerance for light
2. discomfort from fluorescents and other artificial light

3. light avoidance behaviours (e.g. shielding eyes)
4. afterimages
5. visual snow
6. 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 with autism.

Although LightAware has been contacted by a lot of people who have been affected by LED street lighting, it is not possible for LightAware to estimate how many people are affected. 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.

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. 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 may be of a similar order of magnitude as the drivers of sensitivity, such as flicker and glare are the same. However, further research is needed to quantify the number of people affected.

As well as light-sensitive people, others will be affected by high blue contact LED lighting. Although the EU SCHHER 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 their definition of ‘general public’ excluded children, the elderly and light sensitive people, who were classed as ‘vulnerable populations’.

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*.”

Q.17 What are the benefits of better installation, management and use of lighting controls (for example, for the environment, for UK businesses, UK innovation)? Please provide evidence and/or data.

While LightAware supports the use of lighting controls to improve energy use, building users should always have the option of switching off lighting to allow access

by light sensitive people. This is a particular problem in public buildings such as hospitals, where lighting is switched on by movement sensors and staff are unable to switch off lighting to accommodate individuals, such as those suffering from lighting-induced migraines and people on the autistic spectrum who can be overwhelmed by such lighting.

Q.18 To what extent could Government support the installation and management of lighting controls in order to help maximise carbon and bill savings for lighting products? In what form would any potential policy be most effective?

As in Q. 17, while LightAware supports the use of lighting controls to improve energy use, building users should always have the option of switching off lighting to allow access by Light sensitive people.

Q.19 How can energy labels be made more useful for lighting products (e.g. by including average annual/lifetime energy costs, by using more/less text or imagery)?

This is beyond LightAware's competence to respond.

Q.20 How can resource efficiency measures be used to further improve the environmental performance of lighting products throughout the product lifecycle? (Such measures may relate to aspects including materials used, emissions, pollution and waste generation, as well as durability, repairability, recyclability and ease of material recovery.)

This is beyond LightAware's competence to respond.

Q.21 How can Government balance the need to replace inefficient lighting products with more energy-efficient products with the need to maximise the resource efficiency of lighting products, including increasing their durability and expected lifetime?

This is beyond LightAware's competence to respond.

Q.22 Are there any other policy levers which could help lighting products to become more energy efficient or increase the use of the highest efficiency lighting products (e.g. public procurement)?

The most effective levers would be to increase incentives for people to switch off lighting, for example through better regulation to reduce lighting nuisance. For example, shops, car showrooms and many other businesses leave lighting on all

night or when premises are unoccupied. Significant savings could be made by introducing regulations requiring individuals and businesses to switch off unnecessary lighting.

In addition, many light sensitive people are badly affected by their neighbours external lighting, particularly security lighting left on all night. We would request that the legislation for lighting nuisance and light pollution should be extended to protect light sensitive people, for example by requiring nuisance lighting to be on a timer and by allowing local authorities to take account of the impact of the lighting on the light sensitive person. The consequence of this change would be a reduction in energy use and light pollution.

A requirement for businesses and others to use lower CCT lighting, as recommended by the All-Party Parliamentary Group for Dark Skies, would help to reduce light pollution.

Under the draft statutory instrument - The Ecodesign for Energy-Related Products and Energy Information (Lighting Products) Regulations 2021,

Under **Limited exemptions (pages 27 – 29)**

3.— (*1) Regulations 4 to 9, with the exception of paragraph 10 of Schedule 2, do not apply to light sources and separate control gears which are specifically designed and marketed for intended use in any of the applications listed in sub-paragraph (2)….*

….p) light sources provided specifically for use by photosensitive patients, to be sold in pharmacies and other authorised selling points (such as suppliers of disability products), upon presentation of a medical prescription.

This exemption is a direct result of LightAware's involvement in the EU's consultation process. As part of this consultation, the EU requested that LightAware should produce proposals as to how such an exemption should work (paper attached). The EU chose what we felt was a bureaucratic mechanism for making the exemption into effect that we feel might be improved in a UK context. We would welcome discussions with BEIS as to how the exemption could best be put into operation.