Texte zu den geplanten neuen EU-Regelungen zur umweltgerechten Produktgestaltung und zur Energieverbrauchskennzeichnung in der Beleuchtung – Zusammenstellung [1] des Umweltbundesamtes (UBA), Deutschland

Gesundheit

Hintergrundtext:

SCHEER-Stellungnahme [2] zu möglichen Risiken für die menschliche Gesundheit durch Leuchtdioden (LED)

– Ergebnisse der öffentlichen Konsultation im Sommer 2017 –

Hinweis: Bitte beachten Sie, daß der angehängte Text nur in Englisch verfaßt ist.

EN: Information on the coming EU Lighting Regulations – Ecodesign and Energy Labelling – Compilation [1] of the Federal Environment Agency (UBA), Germany

Health

Background information: SCHEER [2] Opinion on Potential risks to human health of Light Emitting Diodes (LED)

– Results of the public consultation in the summer of 2017 –

FR: Informations sur les futures réglementations de l'UE concernant l'éclairage – l'écoconception et l'étiquetage énergétique – Compilation [1] de l'Agence Fédérale de l'Environnement (UBA), Allemagne

Santé

Informations de fond : Avis du SCHEER [2] sur les risques potentiels pour la santé humaine par diodes électroluminescentes (DEL)

– Résultats de la consultation publique de l'été 2017 –

Indication : Veuillez noter que le présent texte n'est disponible qu'en anglais.

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[1] https://www.eup-network.de/de/eup-netzwerk-deutschland/offenes-forum-eu-regelungen-beleuchtung/dokumente/texte/

[2] SCHEER = Scientific Committee on Health, Environmental and Emerging Risks ◊ **DE**: Wissenschaftlicher Ausschuß für Gesundheits-, Umwelt- und aufkommende Risiken ◊ **FR** : Comité scientifique sur la santé, l'environnement et les risques émergents I https://ec.europa.eu/health/scientific_committees/scheer_en

DE: ↓ **EN**: → page III **FR** : → page IV

Texte im Offenen Forum und Kennzeichnung des vorliegenden Textes

- **Bestehende Regelungen**
- **Studien der EU-Kommission**
- **Regelungsentwürfe**
- **Öffentliche Konsultationen auf EU-Ebene**
- **Diskussion im Offenen Forum**
- **Weitere Dokumente**
  - Planung und Entstehung von Rechtstexten
  - UBA-Ansatz zur Bewertung der Stromeffizienz bei Beleuchtungsprodukten
  - Vergleiche von Ansätzen zur Produktbewertung
  - Aus der Alltagspraxis
  - **Gesundheit: SCHEER-Stellungnahme zu möglichen Risiken für die menschliche Gesundheit durch Leuchtdioden**
    - **Texte des SCHEER-Ausschusses**
      - Entwurf vom 7. Juli 2017
      - **Ergebnisse der öffentlichen Konsultation im Sommer 2017**
      - Endfassung vom 6. Juni 2018
    - Arbeitshilfen/Hintergrundtexte
      - Änderungen in der Endfassung vom Juni 2018 gegenüber dem Entwurf vom Juli 2017 *
    - Stellungnahmen
      - Stellungnahme lichtfragen.info (20. August 2018) [DE] [EN]
  - Produkteigenschaften
  - Sonstige

* Stand: 17 .8. 2018: Dieser Text ist noch nicht verfügbar.

Abkürzungen: • • SCHEER: Wissenschaftlicher Ausschuß für Gesundheits-, Umwelt- und aufkommende Risiken; https://ec.europa.eu/health/scientific_committees/scheer_en

EN

Documents in the Open Forum and identification of the text at hand

- **Existing EC and EU Regulations**
- **Studies of the European Commission**
- **Draft regulations**
- **Public Consultations at EU level**
- **Discussion in the Open Forum**
- **Further documents**
  - Planning and development of legal texts
  - UBA's approach to assess the energy efficiency of lighting products
  - Comparisons of approaches to product evaluation
  - From Everyday Practice
  - **SCHEER Opinion on Potential risks to human health of Light Emitting Diodes**
    - **Documents of the SCHEER Committee**
      - Draft as of 7 July 2017
      - **Results of the public consultation in summer 2017**
      - Final version as of 6 June 2018
    - Work aids/Background information
      - Changes in the final version of June 2018 compared to the draft of 6 July 2017 *
    - Comments
      - Comments by lichtfragen.info (20 August 2018) [DE] [EN]
  - Product property
  - Others

* Status as of 17 August 2018: This text is not yet available.

Abbreviations: • SCHEER = Scientific Committee on Health, Environmental and Emerging Risks; https://ec.europa.eu/health/scientific_committees/scheer_en

FR

Documents dans le forum ouvert et marquage du présent document

- **Règlements existants de la CE et de l'EU**
- **Études de la Commission européenne**
- **Projets de règlements**
- **Consultations publiques au niveau de l'UE**
- **Discussion dans le Forum Ouvert**
- **Autres documents**
  - Planification et développement de textes juridiques
  - Approche de l'UBA pour évaluer l'efficacité énergétique des produits d'éclairage
  - Comparaisons d'approches d'évaluation des produits
  - De la pratique quotidienne
  - **Avis du SCHEER sur les risques potentiels pour la santé humaine par diodes électroluminescentes**
    - **Documents de la Comité SCHEER**
      - Projet du 7 juillet 2017
      - **Résultats de la consultation publique à l'été 2017**
      - Version finale du 6 juin 2018
    - Aide de travail/Informations de fond
      - Changements dans la version finale de juin 2018 par rapport au projet de juillet 2017 *
    - Commentaires
      - Commentaires par lichtfragen.info (20 août 2018) [DE] [EN]
  - Caractéristiques du produit
  - Autres

* État au 17 août 2018 : Ce texte n'est pas encore disponible.

Abréviations : • SCHEER : Comité scientifique sur la santé, l'environnement et les risques émergents; https://ec.europa.eu/health/scientific_committees/scheer_en

Es folgt ein unveränderter Originaltext.

EN: The following is an unmodified original text.

FR: Ce qui suit est un texte original.

Results of the public consultation on SCHEER's preliminary opinion

on

"Potential risks to human health of light emitting diodes (LEDs)"

A public consultation on this Opinion was open on the website of the non-food scientific committees from 19 July to 17 September 2017. Information about the public consultation was broadly communicated to national authorities, international organisations and other stakeholders.

Eighty-four organisations and individuals (providing nearly 300 comments and 22 documents) participated in the public consultation providing input to different chapters and subchapters of the Opinion, with the vast majority of comments coming from the industry.

Each submission was carefully considered by the SCHEER and the scientific Opinion was revised to take account of relevant comments. The literature has been accordingly updated with relevant publications.

The SCHEER expresses its thanks to all contributors for their comments and for the literature references provided during the public consultation.

The table below shows all comments received on different chapters of the Opinion and SCHEER's response to them. It is also indicated if the Opinion was changed as a result of a comment.

Comments received during the public consultation on the SCHEER preliminary opinion on "Potential risks to human health of light emitting diodes (LEDs)"

No.	Name of individual/organisation	Table of contents	Submission	SCHEER's response
1.	Asmuss, Monika, Federal Office for Radiation Protection, masmuss@bfs.de, Germany	1. SUMMARY	lines 13-14 and in 35-36: Statements do not fit. If SCHEER believes (based on reliable facts?), that some LEDs in toys may induce retinopathy in children below three years of age, this should be considered in "susceptible groups" as well.	Text of the Opinion has been clarified.
2.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	1. SUMMARY	P7L11. It is not only blue part of the spectra but also violet and blue-green ranges. Peak of blue light hazard function is at ~430nm which is violet rather than blue. Suggest replacing blue with short-wavelengths. P7L15 and P7L32. Replace hazards with risks. P7L14-18. Most important parameter, spectrum, is missing from this list. P7L24. Screens are ambiguous, they may include passive projection screen or marketing posters. Replace with screens of electronic devices. P7L31 (and many other instances throughout the text). The SCHEER concludes… this style sounds rather aloof, suggest This Opinion concludes, or It is concluded that (and similar formulations elsewhere). P7L35. What are direct adverse effects? Explain these limits. P8L1. Not all LEDs flicker or cause dazzle, distraction and glare. May would be more appropriate in this context.	Text of the Opinion was clarified. Text has been amended. The text has been amended. The text has been amended. No change needed. The text has been clarified. Text has been amended. Text has been amended.

			P8L2-8. Repetition, combine. P8L7-9. Wrong logical order. This paragraph should go after Line 1. The relevance of last sentence of this paragraph is also not clear. P8L16-18. Disparity, exophoric shift in nearpoint phoria and effect on vergence are widely accepted as main causes, not only motion sickness. P8L39-41. On axis viewing is not always the worst-case viewing condition if on axis is understood as axis normal to the lamp surface. Thus, GLS LED lamps often include bat-wing optics which produces "doughnut"-type illumination profile, with dark central spot. Dual-use displays for in-car entertainment and/or navigation are designed to produce two viewing zones angled with respect to the screen. P8L44. Although it is true that LED lamps are often more efficient than other sources, efficiency of sodium lamps (100-150 lm/W) is still higher than current LED technology. P8L46 Change "an incandescent lamp" to "any other type of lamp" – this is simply a mathematical consequence of how the CCT is calculated. P8L48 Change "might influence…" to "might influence positively or negatively…compared to other types of lamp."	Text has been amended. Text has been amended. No change is needed. No change is needed. Text has been amended. . Text has been amended.
3.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	1. SUMMARY	Overall remark: This Preliminary Opinion insufficiently addresses the relevant knowledge gaps in this field. Many of its conclusions are derived from hazard evaluations made in terms of the current occupational safety standards, that only address a limited number of potentially harmful effects, under particular lighting conditions, and for the "general healthy population". These limitations of the standards, stated in the standards documentation, seem to be insufficiently recognized in the SCHEER document.	The limitations of ICNIRP guidelines are mentioned already in the Opinion (page 11, lines 32-34 of the preliminary Opinion). ICNIRP does not differentiate between workers and the general public when discussing the biophysical effects and the hazards. The LED-specific issues of the CIE Technical Report are already addressed in the Opinion (small sources and

			The CIE 218:2016 Technical Report "Research roadmap for healthful interior lighting applications" provides comprehensive information regarding some aspects of this issue and should be analyzed and commented in the SCHEER Opinion. CIE 218:2016 not uploaded (> 1MB) Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	flicker). The other issues are general to all lighting and not specific to LEDs.
4.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	1. SUMMARY	page 7, lines 6-7 and 13-14: "The eye and skin are the most susceptible target organs for effects due to optical radiation, and action spectra also exist for effects on skin and eye (ICNIRP, 2013)", "The specific safety requirements and risk assessment methods regarding photobiological hazards are contained within several European safety standards." Not all photobiological hazards for the eye are addressed in current safety standards. Potential hazards derived from long-term, chronic exposure to light at levels below the present occupational safety thresholds (including extended periods at nighttime) are a classical example.	No change is needed.
5.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	1. SUMMARY	p. 7, lines 16-18: "the irradiance (the flux of optical radiation that reaches a target, distance dependent), the radiance (radiation flux leaving the source depending on emission angle, independent of distance to target) " These definitions of irradiance and radiance are unnecessarily incorrect. I suggest to replace them by the standard CIE definitions (widely available). Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	No change is needed.
6.	Bará, Salvador, Universidade de Santiago de	1. SUMMARY	p. 7, lines 39-41 (also applicable to Section 6.5 Eye optics fundamentals) "Indeed, the absence of ultraviolet radiation from general LED lamps may	Text has been clarified.

	Compostela, salva.bara@usc.es, Spain		reduce the risk of photosensitivity for a number of these conditions." While the absence of UV emission is indeed a relevant advantage of LEDs from the viewpoint of photobiological hazards, the SCHEER opinion should take into account that the retinal damage does not depend only on the power spectral density of the lamps. The spatial distribution of the retinal irradiance is mainly dependent on the radiance at the entrance of the eye. LED chips may have extremely high radiances (higher than most traditional light sources), and, if not properly fitted with adequate diffusers, they may give rise to high irradiances in localized retinal regions. Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	No change is needed.
7.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	1. SUMMARY	p. 7 lines 42-44 (also applicable to Section 6.8 Circadian rhythms): "Short-wavelength light (peak around 480 nm) influences the circadian system, but the full-action spectrum for the influence of light on the circadian system is not completely clear yet as other wavelengths have an influence as well." Although many unknowns remain regarding the complex interaction of light with the human circadian system, action spectra for several effects (e.g. acute melatonin suppression, under definite experimental conditions) are fairly well known, and several physiologically-based models have been developed for predicting the outcomes of the exposure to different irradiance distributions. As a single example, among others, see: - Rea MS, Figueiro MG, Bullough JD, Bierman A. A model of phototransduction by the human circadian system. Brain Research Reviews 2005; 50:213–228. - Rea MS, Figueiro MG, Bierman A, Hamner R. Modeling the spectral sensitivity of the human circadian system. Lighting Research & Technology	Text has been amended

			2012; 44:386–396. Corrigendum: Lighting Research & Technology 2012; 44:516. and references therein. Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	
8.	Udovicic, Ljiljana, Federal Institute for Occupational Safety and Health, Friedrich-Henkel-Weg 1-25, D-44149 Dortmund, udovicic.ljiljana@baua.bund.de, Germany	1. SUMMARY	Summary p. 8, line 46-48 "However, the infrared (and possible ultraviolet emission) will be greatly reduced or absent, which might influence the normal bioprocesses in humans. This aspect is still under investigation." It would be good to offer some literature supporting this hypothesis.	Text has been amended.
9.	Wunsch, Alexander, Medical Light Consulting, praxis@alexanderwunsch.de, Germany	1. SUMMARY	P. 7 lines 24-26: The calculation (less than 10%) is based on relatively old concepts. Hunter et al. (Hunter, J.J., Morgan, J.I., Merigan, W.H., Sliney, D.H., Sparrow, J.R. & Williams, D.R., 2012, The susceptibility of the retina to photochemical damage from visible light, Progress in retinal and eye research, 31(1), pp. 28-42.) address the actual limits for photochemical hazards. They discuss new findings, the phenomena RPE AF photobleaching and RPE photodamage, which may involve different mechanisms of photochemical damage which have not been addressed e.g. by ICNIRP. The authors state: "Our observations of RPE disruption and AF photobleaching at light levels below the ANSI photochemical MPE (560 J/cm2) are alarming.". They give explanations why the safety levels based on animal experiments might be by far too high due to shortcomings in the experimental setting. E.g.: "Even when monkeys are anesthetized, movement of the eye is still observed and could spread the light exposure over a larger area than intended, thereby reducing the actual retinal radiant exposure."	The paper is outside the scope of this Opinion.

			The phenomenon of RPE disruption might represent a sensitive sign for photochemical damage. "RPE disruption occurs at light levels at or slightly below the MPE, which is alarming because the MPE is typically about 10 times below the damage threshold for small lesions and 2e3 times below for large lesions (American National Standards Institute, 2007)." The authors (David Sliney is one of them) discuss the impact of the new findings on safety standards and emphasize that the underlying mechanisms of photodamage must be fully understood. Conclusion: If a screen reaches only 10% of the radiance limit for photochemical damage, but the limits might be more than 10 times too high according to recent findings, a photochemical damage is still possible.	
10.	Lincoln, John, LightAware, john@lightaware.org, United Kingdom	1. SUMMARY	Page 7, lines 21-22; The comment: "exposure to optical radiation from LEDs is likely to be insignificant compared with the exposure to natural light outdoors" ignores the crucial fact that natural light (and artificial light from non-LED sources) is diffuse and uniform in terms of density, whereas the light from LEDs is highly concentrated. See `… unlike traditional sources LEDs are small, directional, and very bright as discrete emitters. Therefore, using an array of them without secondary optics typically produces substantially nonuniform luminous intensity distribution … M. Nisa Khan, Understanding LED illumination, p91, CRC Press, 2014. Page 7, Lines 27 - 30 "The search of the literature for the long-term impact of LED emissions on human health did not identify any studies since the technology has been recently distributed." Given the potential for LEDs to induce photochemical retinopathy, particularly in children, it is incumbent on the EU to commission research on this issue as a matter of urgency. Many retinopathies, for example age related macular degeneration, only	No change is needed. This aspect has been already addressed. No change is needed. This aspect has already been addressed.

			manifest themselves after a considerable period. There is a risk that a small increase in retinal damage in children and young people could lead to a significant increase in retinopathies over the long term. For example, young children lying on their backs in prams would receive much higher levels of LED emissions from LED street lighting than their parents. Smaller children's eyes are at car headlight level and will receive much higher emissions than adults. Given, there is no long-term (or even medium-term) research in this area, it would be prudent to invoke the precautionary principle and delay the mass introduction of LED lighting until an adequate amount of academic research has been completed. Page 7, Line 48 Contrary to the view expressed in line 48 that 'it is not yet clear if this disturbance of the circadian system leads to adverse health effects' There is a considerable body of evidence that blue light can adversely affect sleep patterns and that poor sleep patterns can have adverse health effects. For example, Action spectrum for melatonin regulation in humans: evidence for a novel circadian photoreceptor, GC Brainard, et al, Journal of Neuroscience 21 (16), 6405-6412 and Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness, Anne-Marie Changa, et al, PNAS, January 2015.	Risk management issues are outside the scope of the SCHEER. Text has been amended.

11.	Asmuss, Monika, Federal Office for Radiation Protection, masmuss@bfs.de, Germany	3. OPINION AND CONCLUSIONS	General: Generally it was difficult to understand the structure of the paper and the way, how the authors came to their conclusions. Different types of exposure (e.g. domestic lighting, car lamps, toys, displays, sources used for medical Treatment) are not regarded seperately. But risk assessment depends on exposure conditions as well. Often I missed a clearer distinction between potential health effects of optical radiation in general and the specific health relevant hazards of LEDs. Beside this general comment: p 11, line 29-30: A "hazard" cannot be 10-20% of a Limit. p11, line 48-50: Misleading. Risk assessment has to be done for each source seperately, in this case for LED. It is not possible "to take into account the total exposure of a person in a given 24 h period" - unless the person carries a Dosimeter. p 13, line 15: Which "blue light hazard Limit" is meant? ICNIRP recommendation?	No change is needed. No change is needed. No change is needed. The comment does not contradict the Opinion. The text has been amended.

12.	Hannevik, Merete, Norwegian Radiation Protection Authority, merete.hannevik@nrpa.no, Other	3. OPINION AND CONCLUSIONS	p 11, line 6-7: substitute "does not penetrate" with "has Limited penetration". Direct damage is confined to areas of absorption but indirect effects may occur at distant sites. p11 line29-30: The Expression photochemical retinal hazard sholud be modified to a dose-unit comparable to the limit, eg use wording as in p 7 line 24-26 p12 line 14-21. The statement is unclear. What is meant by high component of the short-wavelength, refer to a figure of typical spectral distribution? It sounds like a full action Spectrum is close, is that the situation? Which other wavelengths may have an influence on circadian rythms? p13, line57. What is meant by the normal bioprocesses in humans?	The text has been amended. The text has been amended for consistency. The text has been amended. The text has been amended.
13.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	3. OPINION AND CONCLUSIONS	2.1 Background P9L8. There is insufficient evidence to support the statement that LEDs last much longer than other conventional light sources. Suggest to add may last … P9L21-24. Two very important parameters are missing from this list: source size (e.g., near-point source or diffuse) and flicker. Opinion P11L13. Would workers be better than professionals here, as not all workers are part of some profession? P11L6. Insert the entire body P11L23. …without significant red… But see Figure 3 which contradicts this. If it were true, red objects would be very poorly illuminated (it would be look like being several metres underwater) and the CRI (colour rendering index) test R9 scores would be at least an order of magnitude lower than they actually are for most LEDs (and LEDs would not be acceptable for lighting.)	This is the text from the mandate. No changes needed. The text has been amended. The text has been amended. No change is needed The text has been amended.

			P11L30. Insert unbroken viewing… or viewing without looking away	No change is needed.
			P11L45. True, but it is incomplete. Other dose formulae are possible and would be more accurate in some important realistic cases. In general, the choice of dose formula depends on the response in question (and this time-dependence should not be confused with the difference between dose and dose-response). Similarly, restricting the assessment to an exposure period of up to 24 hours may not always be justified, even for acute effects.	The text has been amended.
			P12L16. This may be inaccurate. In a recent (2015) market sample, most blue LED components used in lighting peak around 450 – 460 nm (and a trough from around 480 – 500 nm), also see Figure 3. If this was meant as the peak of the circadian system, this is not clear from what is written.	The text has been amended.
			P12L19-20. What is screen technology? CRT could also be called screen technology. Personal digital devices may be more accurate.	No change is needed.
			P12L33, also see P10L29. relationships (plural)?. This answer to Q2 is very confused. Before considering dose-response, it needs to be set out what response is being considered. For eye-mediated Reponses alone, there are separate dose-response curves for pupil constriction, visibility, melatonin phase shifting, short-wavelength phototoxicity, etc. Some of these are well-known, and some are context-dependent and the subject of ongoing research. The answer to this question should include consideration of each important response, as though the question meant relationships rather than relationship.	No change is needed.
			P12L43-44. Blue light hazard is expressed as spectrally weighted radiance and reference to the spectra only is inaccurate.	The text has been amended.
			P13L9. Not correct. Eye movement does not decrease retinal irradiance, it moves it between different locations. Eye movement reduces the radiant	The text has been amended.

			exposure, and only where the surrounding retinal irradiance is lower. P13L23 and P14L31. There is no reference to EN 62115:2017 in Bibliography. Add full reference. P13L29. Add for new vehicles P14L4. Insert glare or high contrast. P14L11. Most of this section on flicker is good, but it is not usual or even-handed to refer to published research as "some claims". In fact, there are a number of publications from a number of research groups over at least 40 years providing evidence of adverse effects from >= 100Hz flicker. It should be written and handled with more rigour. P14L24. Again claims is quite odd wording for a simple physical phenomenon (scattering by fog), when the source is known to be brighter (blue-ness may contribute too, but this effect is primarily related to brightness).	The text has been amended. No change is needed. The text has been amended. The text has been amended The text has been amended.
14.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	3. OPINION AND CONCLUSIONS	p. 11, lines 37-39: "Radiant intensity (W/sr) is a parameter characterising the emission of the source, while luminous intensity (lm/sr) is important in terms of visual perception including distraction, glare and after-images." Radiance (Wm^-2sr^-1) and luminance (cd/m`2), not radiant intensity and luminous intensity, are the key basic magnitudes for analyzing visual perception and health effects.	No change is needed.
15.	John, Lincoln, LightAware, john@lightaware.org, United Kingdom	3. OPINION AND CONCLUSIONS	Page 8, Line 1 Line 1, states that "LEDs do have issues in terms of flicker, dazzle, distraction and glare." The EU should establish clear standards for acceptable dazzle and glare, until then there will be no way of enforceable regulation. They are important in several areas, for example in headlight design and road safety Dazzle and glare from LEDs also cause or exacerbate migraine	Already addressed above.

			attacks in vulnerable people. 30–60% of migraine attacks are triggered by light or glare and migraineurs are more light sensitive during and between migraine attacks see Shedding Light on Photophobia, Kathleen B. Digre, MD and K.C. Brennan, MD, J Neuroophthalmol. 2012 Mar; 32(1): 68–81. The report states that "Flicker from some LED lamps can result in stroboscopic effects. There are claims by small number people of adverse health effects such as migraine or headaches. There appear to be no technical reasons why LED lamps need to flicker since many models do not." It is long established that flicker and stroboscopic effects cause migraines and headaches (and can lead to epileptic fits in susceptible individuals). Given this, we suggest that the EU sets standards for the stability of the electronic circuits that drives LED bulbs ensure that they do not flicker. In addition, dimmer switches and lighting control systems can significantly increase the level of flicker in LED lighting that is poorly designed or manufactured. Page 8, Line 12 Young children lying on their backs in prams could receive much higher levels of LED emissions from LED street lighting than their parents, leading to retinopathy. Smaller children's eyes are at car headlight level and will receive much higher emissions than adults. Page 8, Lines 24 -26 These lines illustrate why LED lights specifically problematic for car headlights and streetlighting and the report should state this clearly. This is made worse by the lack of clear standards and guidelines for streetlighting using LEDs, which can lead to poor choices by local authorities in the specification of street lighting employed. Page 8, Lines 26-27	

			Older people are much more vulnerable to glare and dazzle and the retina of an 80-year-old receives far less light than the retina of a 20-year-old. In addition, the aging cornea and lens in the eye become less clear as we age, causing light to scatter inside the eye, which increases glare. These changes also reduce contrast sensitivity, the ability to discern subtle differences in brightness, making it harder to see objects particularly on the roadway at night. This is of crucial importance for road safety for older drivers. Many older drivers choose not to drive at night and this number may increase dramatically because of the glare from LED headlights and street lighting. If this happens it will increase problems of social isolation for older people. Page 8, Line 48 Again, the widespread introduction of LEDs should be delayed until investigations are complete.	No change is needed. Risk management issues are outside the scope of the SCHEER.
16.	Lincoln, John, LightAware, john@lightaware.org, United Kingdom	3. OPINION AND CONCLUSIONS	Page 8, Line 1 see submitted text Page 8, Line 12 see submitted text Page 8, Lines 24 -26 see submitted text Page 8, Lines 26-27 - see submitted text Page 8, Line 48 - see submitted text Page 11, Lines 22 -27. - see submitted text Page 11, Lines 26 -27. - see submitted text Page 12, Line 1 - see submitted text Page 12, Line 9 - see submitted text Page 12, Line 20 - see submitted text Page 13, Lines 34 – 45 - see submitted text Page 14, Lines 8 - 16 see submitted text	See comments to relevant text. LightAware_opinion_ Final_answers-1ww.c LightAware_Respons e_to_SCHEER_-_abst

			Page 14, lines 35 -37 - see submitted text A document ' LightAware_Opinion' was submitted including all comments from LightAware.	
17.	Asmuss, Monika, Federal Office for Radiation protection, masmuss@bfs.de, Germany	5. DATA AND METHODOLOGY	p 15, line 3: According to p 15, lines 29 and p 16, line 1, experimental studies have been taken into account as well. If so, it should be "...available evidence from human, animal and mechanistic studies".	Text has been amended.
18.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	5.1 Data/Evidence	P15, Legend to Fig 1. Suggest tox is written toxicology and epi as epidemiological. Bradford hill should be Bradford Hill.	The text has been amended.
19.	Hannevik, Merete, Norwagian Radiation Protection Authority, merete.hannevik@nrpa.no, Other	5.2 Methodology	p 16 line 8. What information does the figure give in this context? It is not further discussed in the text.	The text has been amended.
20.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	5.2 Methodology	P16, Legend to Fig 2. Should this be labelled …as dose of optical radiations reaches low levels? P16L20. What does optical radiation geometry mean? Optical radiation may be characterised by wavelength, temporal pattern, source size, etc, and geometry is not one of them. P16L27-28. It is not clear what instantaneous or time-averaged limits are, there are ICNIRP exposure limits but ICNIRP doesn't define instantaneous or time-average. Overall, L25-30 are very unclear and needs re-wording. P17L1. Replace adverse impact of the optical radiation on vision with temporarily visual impairment.	The text has been amended. The text has been amended. No change is needed. The text has been amended.
21.	Garcia Gil , Manuel, Generalitat de Catalunya, spcall.tes@gencat.cat, Spain	6.10 Exposure and health risk scenarios	The Service of prevention of light pollution is Catalan regional administration, which is part of the Generalitat de Catalunya. This entity has more than 15 years of experience in the analysis and sustainability of outdoor lighting and light pollution. Regulations have	Risk management issues are outside the scope of the SCHEER.

			been valid since 2001: -LAW 6-2001, of May 31, on the environmental management of lighting for the protection of the night environment. - DECREE 190-2015, of 25 August, on the implementation of Law 6-2001, of May 31, on the environmental management of lighting for the protection of the night environment. Technical contact: manuel.garciagil@gencat.cat Page 39: Lines: 8-11 If a reform is done thinking about the improvement and the energy saving, also must take into account factors of quality of light service (already exposed in the one drafted), but also of environmental analysis, as the light pollution. The increase in blue component generally represents an important factor in the increase of this pollution, reason why it must be considered in the alternatives of the project (Bará 2016). (Longcore 2004, Rich and Longcore 2006, Kinzey, Perrin et al. 2017).It is an analysis that should not be forgotten in outdoor lighting(Bará 2013). Bará, S. (2013). "Light pollution and solid-state lighting: reducing the carbon dioxide footprint is not enough." SPIE Procedings 8785(1). Bará, S. (2016). "Anthropogenic disruption of the night sky darkness in urban and rural areas." Royal Society Open Science 3(10). Kinzey, B., T. E. Perrin, K. Miroslav, M. Aubé and H. A. Solano Lamphar (2017). An Investigation of LED Street Lighing's Impact of Sky Glow. U. S. Department of Energy. Longcore, T., Rich C. (2004). "Ecological light pollution." Frontiers in Ecology and the Environment 2(4): 191-198.	

			Rich, C. and T. Longcore (2006). Ecological Consequences of Artificial Night Ligthing. Washington, DC, Island Press.	
22.	Garcia Gil, Manuel, Generalitat de Catalunya, spcall.tes@gencat.cat, Spain	6.10 Exposure and health risk scenarios	The Service of prevention of light pollution is Catalan regional administration, which is part of the Generalitat de Catalunya. This entity has more than 15 years of experience in the analysis and sustainability of outdoor lighting and light pollution. Regulations have been valid since 2001: LAW 6-2001, of May 31, on the environmental management of lighting for the protection of the night environment. DECREE 190-2015, of 25 August, on the implementation of Law 6-2001, of May 31, on the environmental management of lighting for the protection of the night environment. Technical contact: manuel.garciagil@gencat.cat Page 39: Lines 12-20: CCT is a way of measuring the blueness of an optical radiation, everything and that is not enough. It is recommended to use other aspects, since for the LED, it should not be the most optimal way to represent it. (Galadi 2017) From the technical point of view, it is possible to carry out CCT between 2200K and 7000 K for white light, or even amber light, using the PC-amber system (for most manufacturers). The PC-amber system also has high efficiency and minimizes environmental impact since it has a% of radiation below 1% below 500 nm. There is also more harmful radiation filtering systems, which allow for high efficiencies. The light of the moon has a maximum of 0.3-0.4 lux of light level on the horizontal surface (Kyba, Mohar et al. 2017). These values are very low, for the human,	Risk management issues are outside the scope of the SCHEER.

			who is an animal of essentially diurnal vision. The vision that takes place in the places illuminated at night is in general mesopic (typical values between 7,5-30 lx), and the one by means of the illumination of the moon, generally scotopic. The ways of seeing, of perceiving colors and forms, are different for all of them, and must be considered in a very particular way, and careful, as well denoted by the technical report CIE 191:2010. In addition, the equalization of the moonlight, for nocturnal animals, and that can have cycles and life adapted to it, is possible (Kronfeld-Schor, Dominoni et al. 2013), but not for the human. So the argument of 4000K is not recommended in reference to this. There is a law published in Catalonia Decree 190/2015 of 25 August and written in 2014, which already prescribe 4200 K, but also 3000K and Amber lighting depending of the protection zone. We considered appropriate to study the reduction of this value, as well as the possibility of improving the form of measurement, according to current scientific knowledge, and the market potential (and its performance improvement for low emission lamps under radiation below 500 nm), because a significant increase in light pollution can occur (Falchi, Cinzano et al. 2016). Falchi, F., P. Cinzano, D. Duriscoe, C. C. M. Kyba, C. D. Elvidge, K. Baugh, B. A. Portnov, N. A. Rybnikova and R. Furgoni (2016). "The new world atlas of artificial night sky brightness." Science Advances 2(6). Kronfeld-Schor, N., D. Dominoni, H. de la Iglesia, O. Levy, E. D. Herzog, T. Dayan and C. Helfrich-Forster (2013). "Chronobiology by moonlight." Proceedings of the Royal Society B: Biological Sciences 280(1765). Kyba, C. C. M., A. Mohar and T. Posch (2017). "How bright is moonlight?Moonlight." Astronomy & Geophysics 58(1): 1.31-31.32.	
23.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	6.10 Exposure and health risk scenarios	P39L10-11. Replace optical with emission and add illumination before light.	The text has been amended. The text has been amended.

			P39L30. Add and in environment after the eyes	
24.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	6.10 Exposure and health risk scenarios	6.11 Overall conclusions P39L35-40. It seems to be missed that LEDs, unlike CFLs, can easily have 100% modulation at 100 Hz and/or with a lower duty cycle. In fact, in some ways manufacturers may select for this for cost reasons and for dimming purposes using Pulse-Width Modulation (PWM). Consequently, LEDs could potentially increase the adverse effects possible from flickering lighting compared to other lighting types.	The text has been amended.
25.	Gutiérrez, Sara, Universidad Complutese de Madrid, saracagu@ucm.es, Spain	6.10 Exposure and health risk scenarios	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. BLUE LIGHT EMITTING DIODE INDUCES APOPTOSIS IN LYMPHOID CELLS BY STIMULATING AUTOPHAGY The present study was performed to examine the induction of apoptotic cell death and autophagy by blue LED irradiation, and the contribution of autophagy to apoptosis in B cell lymphoma A20 and RAMOS cells exposed to blue LED. Irradiation with blue LED reduced cell viability and induced apoptotic cell death, as indicated by exposure of phosphatidylserine on the plasma outside membrane and fragmentation of DNA. Furthermore, the mitochondrial membrane potential increased, and apoptotic proteins (PARP, caspase 3, Bax, and bcl-2) were observed. In addition, the level of intracellular superoxide anion (O2(-)) gradually increased. Interestingly the formation of autophagosomes and level of LC3-II were increased in blue LED-irradiated A20 and RAMOS cells, but inhibited after pretreatment with 3-methyladenine (3-MA), widely used as an autophagy inhibitor. Inhibition of the autophagic process by pretreatment with 3-MA blocked blue LED irradiation-induced caspase-3 activation. Moreover, a significant reduction of both the early and late phases of apoptosis after transfection with ATG5 and beclin 1 siRNAs was shown by the annexin V/PI staining, indicating a crucial role of autophagy in blue	This is out of scope of the Opinion.

			LED-induced apoptosis in cells. Additionally, the survival rate of mice irradiated with blue LED after injection with A20 cells increased compared to the control group. Our data demonstrate that blue LED irradiation induces apoptosis via the mitochondrial-mediated pathway, in conjunction with autophagy. Further studies are needed to elucidate the precise mechanism of blue LED-induced immune cell death. Oh PS, Hwang H, Jeong HS, Kwon J, Kim HS, Kim M, et al. Blue light emitting diode induces apoptosis in lymphoid cells by stimulating autophagy. The international journal of biochemistry & cell biology. 2016;70:13-22.	
26.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	6.10 Exposure and health risk scenarios	p. 39, lines 17-19: "Moonlight has a CCT of about 4000 K, so it could be argued that artificial street lighting should not exceed this value." This is a traditional (and somewhat misleading) comparison that that does not take into account the fact that the Moon illuminance is always below ~0.27 lx, while artificial outdoor illumination levels are several tens or hundreds times higher, and that the visual and non-visual effects of both kinds of sources are not directly comparable. The use of sources with CCT equal to or smaller than ~2700 K should probably be recommended instead, in order to mitigate environmental impacts and be consistent with the Kruithof optimal region for humans at typical street illuminance levels. p. 39, lines 19-20: "However, it is important that the lighting installation is appropriate for the use of the road (e.g., motorways may justify higher CCT lighting than residential roads)." Recent research does not seem to support the need of higher CCT lamps (e.g. white LEDs vs high-pressure sodium) for reducing traffic casualties. See, e.g.: - Steinbach R, Perkins C, Tompson L, et al. The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis. J Epidemiol Community Health 2015;	Risk management issues are outside the scope of the SCHEER. No change is needed.

			69:1118-1124. doi:10.1136/jech-2015-206012. (not uploaded, >1 MB) Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	
27.	Public Health England, marina.khaziva@phe.gov.uk, United Kingdom	6.2 Physical characteristics of LEDs sources	P19L12-15. Wrong order. Move this sentence before Line 10. P19, Figure 3 caption. Refer to the source of this graph. Also, what does equivalent mean, inequivalent in what parameter? P19L18-19. If only sun is used for comparison, why not use sun instead of natural optical radiation sources?	No change is needed. Text has been amended. No change is needed.
28.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	6.2 Physical characteristics of LEDs sources	p. 19, lines 20-22 (Also applicable to the statement in p. 24, l. 49-50): "It can be seen that the spectral irradiance from the sky is about two orders of magnitude greater than from the LED or incandescent lamp over a considerable part of the spectrum shown." This is a somewhat misleading comparison. Retinal damage depends, among other factors, on the retinal irradiance, which is determined by the radiance at the entrance of the eye, not by the corneal irradiance. Both metrics are different; they may be deemed equivalent only in very particular cases. The fact that the spectral irradiance from the sky is much smaller than the one of artificial light sources has little practical significance for this kind of hazards. However, the spectral radiance of incandescent light filaments and, particularly, the one of bare LED chips, is many orders of magnitude higher than that of the sky. Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	The figure does not refer to direct viewing of a source, therefore the comment is not relevant. No change in the text is required.
29.	Public Health England, marina.khazova@phe.g	6.4. The fundamental	P21L4 and 8. Suggest delete electromagnetic as unnecessary (and possibly confusing)	The text has been amended.

	ov.uk, United Kingdom	interaction between light and matter	P21L7. Transmission is not an interaction mechanism, absorption is. Replace transmission with absorption. P21L11. Replace interactions with mechanisms.	
30.	Asmuss, Monika, Federal Office for Radiation protection, masmuss@bfs.de, Germany	6.5. Eye optics fundamentals	p 27 lines 1-4 LEDs "with lower blue component" for domestic lighting are recommended for prevention of photochemical retinal injury. Does that mean in fact, that SCHEER sees a risk for the retina, if LEDs for domestic lighting with a higher blue component are used? If so, this assessment is not explained in the text and not consistent with the general summary. If so, it should be specified, which type of LEDs for domestic lighting are hazardous to the retina in the view of SCHEER. In this context I would like to mention, that the topic of risks groups according to EN 62471 is completely missing in the opinion.	Text has been amended.
31.	Point , Sebastien , Société Française de Radioprotection, section Rayonnements Non Ionisants, sebastienpoint@eaton.com, France	6.5. Eye optics fundamentals	In the paragraph 6.5.2.3 (Posterior segment of the eye), it could be useful to deeper discuss the validity of animals models used in recent blue light exposure experiments (especially in Shang et al, 2013; Jaadane et al, 2015; Shang et al, 2017), on the basis of the two following remarks: -Albino Sprague-Dawley rats are quite unsuitable models, especially when trying to extend results to human retina: indeed, the rhodopsin-rich rat retina is subject to Noell's class damage, appearing on visual receptors after long exposures (from few hours to several days) under low illumination (typically <1 mW / m2) (Noell et al, 1966). Once the retinal lesions have appeared, it is difficult to deduce the etiology by histological observations and to conclude where damage is very firstly initiated. It cannot be excluded that the damage observed is not Ham's class damage but Noell 's class damage, which is not observed in humans but is typical of small nocturnal animals, in which the sensitivity of the retina is adapted to low levels of radiance. It should also be noted that in some studies (for example Shang et al, 2013), prior to light	The validity of animal models and *in vitro* studies are discussed in the Opinion. No change is needed.

			exposure experiments, rats are kept in the dark during a significant period to eliminate potential effect of previous not controlled light exposure, although it has been shown that retina of rat kept in darkness is richer in rhodopsin (Organisciak et al, 1989);Rhodopsin is yet believed to be one of the initiating sites for the production of ROS (Youssef et al, 2011). Lastly, the iris of albino rat eye is transparent and diffuses some light and this must be taken into account for retinal irradiance calculation, what is done in (Jaadane et al, 2017). -Point and Lambrozo (Point, 2017) emphasized fundamental differences between rat and human eyes geometries, which were already raised by Sliney (Sliney, 1994) and converted the different retinal exposure levels calculated in (Jaadane et al, 2015) into corresponding source radiances in the case of a human eye. This allowed them to evaluate whether, as pointed out recently by several authors, current Exposure Limits Values (ELV) are not protective and have to be revised. Point & Lambrozo came to the conclusion that it is currently not demonstrated that ELV are not protective enough and warned that extrapolation of exposure results from rat to human was not made with enough caution in some recent studies. This work also pointed out the fact that exposing rat models to domestic radiance or domestic corneal irradiance is not relevant as the corresponding retinal irradiance is highly different between rats and humans. Shang et al., White Light-Emitting Diodes (LEDs) at Domestic Lighting Levels and Retinal Injury in a Rat Model, Environmental Health perspectives, December 2013. Jaadane et al., Retinal damage induced by commercial light emitting diodes (LEDs), free radical biology and medicine, 84 (2015) 373-384. Shang et al., Light-emitting-diode induced retinal damage and its wavelength dependency in vivo, Int J Ophtalmol, Vol 10, N°2, Feb.18, 2017.	

			Noell et al., Retinal damage by light in rats, Investigative Ophtalmology, Vol 5, N°5, October 1966. Organisciak et al, Retinal light damage in rats exposed to intermittent light. Comparison with continuous light exposure. Invest Ophtalmol Vis Sci 1989; 30(5):795-805. Jaadane et al, Effects of white light-emiiting diode (LED) exposure on retinal pigment epithelium in vivo, J.Cell Mol.Med. DOI:10.1111/jcmm.13255, 2017. Youssef et al, Retinal light toxicity, Eye (2011) 25, 1-14. Point & Lambrozo, Some evidences that white LEDs are toxic for human at domestic radiance?, Radioprotection.DOI:10.1051/radiopro/2017026 D. Sliney, Quantifying retinal irradiance levels in light damage experiments , Curr. Eye Res., 1984	
32.	Hannevik, Merete, Norwegian Radiation Protection Authority, merete.hannevik@nrpa.no, Other	6.5. Eye optics fundamentals	p 26 line 27 this section mentions only one study which is not directly linked to LEDs, could the section be omitted because it is weak? Does it refer to the primary reference or should that be: Joo J, Sang Y. Exploring Koreans` Smartphone usage;: an Integrated model of the Technology acceptance model and uses and gratifications theory. Comput Human Behav. 2013;29: 2512-2518? p 26 line 36 The section is weak since it does not contain any References, only hints to claims and non-peer-reviewed studies.	No change is needed.
33.	Gutiérrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) LIGHT-EMITTING-DIODE INDUCED RETINAL DAMAGE AND ITS WAVELENGTH DEPENDENCY IN VIVO • AIM: To examine light-emitting-diode (LED)-induced	No change is needed.

			retinal neuronal cell damage and its wavelength-driven pathogenic mechanisms. • METHODS: Sprague-Dawley rats were exposed to blue LEDs (460 nm), green LEDs (530 nm), and red LEDs (620 nm). Electroretinography (ERG), Hematoxylin and eosin (H&E) staining, transmission electron microscopy (TEM), terminal deoxynucleotidyl transferase dUTP nick end labeling (TUNEL), and immunohistochemical (IHC) staining, Western blotting (WB) and the detection of superoxide anion (O2-·), hydrogen peroxide (H2O2), total iron, and ferric (Fe3+) levels were applied. • RESULTS: ERG results showed the blue LED group induced more functional damage than that of green or red LED groups. H&E staining, TUNEL, IHC, and TEM revealed apoptosis and necrosis of photoreceptors and RPE, which indicated blue LED also induced more photochemical injury. Free radical production and iron-related molecular marker expressions demonstrated that oxidative stress and iron-overload were associated with retinal injury. WB assays correspondingly showed that defense gene expression was up-regulated after the LED light exposure with a wavelength dependency. • CONCLUSION: The study results indicate that LED blue-light exposure poses a great risk of retinal injury in awake, task-oriented rod-dominant animals. The wavelength-dependent effect should be considered carefully when switching to LED lighting applications. Shang YM, Wang GS, Sliney DH, Yang CH, Lee LL. Light-emitting-diode induced retinal damage and its wavelength dependency in vivo. International journal of ophthalmology. 2017;10(2):191-202.	
34.	Gutiérrez , Sara, Universidad Complutense de Madrid, saracagu@ucm.es,	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2017_Serezhnikova_Age-Related Adaptive Responses of Mitochondria of the Retinal Pigment Epithelium to the Everyday Blue LED	Text has been amended and the reference list has been updated.

			Lighting.	
35.	Rodriguez, Xabier, Universidad Complutense de Madrid, Xabierro@ucm.es,	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2017_Nakashima_Blue light-induced oxidative stress in live skin	The reference list has been updated.
36.	Rodriguez, Xabier, Universidad Complutense de Madrid, Xabierro@ucm.es,	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2016_Kim_ Effects of different light wavelengths from LEDs on oxidative stress and apoptosis in olive flounder (Paralichthys olivaceus) at high water temperatures.	No change is needed.
37.	Gutiérrez , Sara, Universidad Complutense de Madrid, saracagu@ucm.es,	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2017_Bullough_Evaluating the Blue-Light Hazard from Solid State Lighting	The reference list has been updated.
38.	Gutierrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2016_Kim_ Functional and morphological evaluation of blue light-emitting diode-induced retinal degeneration in mice	No change is needed.
39.	Gutierrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2017_Hatori_Global rise of potential health hazards caused by blue lightinduced circadian disruption in modern aging societies	No change is needed.
40.	Rodriguez, Xabier, Universidad Complutense de Madrid, Xabierro@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2017_Sang-il Park_ The Protective Effect of Brown-, Gray-, and Blue-Tinted Lenses against Blue LED	No change is needed.

			Light-Induced Cell Death in A2E-Laden Human Retinal Pigment Epithelial Cells	
41.	Gutierrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. BLUE LIGHT-INDUCED RETINAL LESIONS, INTRARETINAL VASCULAR LEAKAGE AND EDEMA FORMATION IN THE ALL-CONE MOUSE RETINA Little is known about the mechanisms underlying macular degenerations, mainly for the scarcity of adequate experimental models to investigate cone cell death. Recently, we generated R91W;Nrl−/− double-mutant mice, which display a well-ordered all-cone retina with normal retinal vasculature and a strong photopic function that generates useful vision. Here we exposed R91W;Nrl−/− and wild-type (wt) mice to toxic levels of blue light and analyzed their retinas at different time points post illumination (up to 10 days). While exposure of wt mice resulted in massive pyknosis in a focal region of the outer nuclear layer (ONL), the exposure of R91W;Nrl−/− mice led to additional cell death detected within the inner nuclear layer. Microglia/macrophage infiltration at the site of injury was more pronounced in the all-cone retina of R91W;Nrl−/− than in wt mice. Similarly, vascular leakage was abundant in the inner and outer retina in R91W;Nrl−/− mice, whereas it was mild and restricted to the subretinal space in wt mice. This was accompanied by retinal swelling and the appearance of cystoid spaces in both inner and ONLs of R91W;Nrl−/− mice indicating edema in affected areas. In addition, basal expression levels of tight junction protein-1 encoding ZO1 were lower in R91W;Nrl−/− than in wt retinas. Collectively, our data suggest that exposure of R91W;Nrl−/− mice to blue light not only induces cone cell death but also disrupts the inner blood–retinal barrier. Macular edema in humans is a result of diffuse capillary leakage and microaneurysms in the macular region. Blue light exposure of the R91W;Nrl−/− mouse could therefore be used to study molecular events preceding edema formation in a cone-rich environment, and thus potentially help to develop	No change is needed.

			treatment strategies for edema-based complications in macular degenerations. Geiger P, Barben M, Grimm C, Samardzija M. Blue light-induced retinal lesions, intraretinal vascular leakage and edema formation in the all-cone mouse retina. Cell death & disease. 2015;6:e1985.	
42.	Rodríguez, Xabier, Universidad Complutense de Madrid, xabierro@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. COLORED LENSES SUPPRESS BLUE LIGHT-EMITTING DIODE LIGHT-INDUCED DAMAGE IN PHOTORECEPTOR DERIVED CELLS Blue light-emitting diodes (LEDs) in liquid crystal displays emit high levels of blue light, exposure to which is harmful to the retina. Here, we investigated the protective effects of colored lenses in blue LED light-induced damage to 661W photoreceptor-derived cells. We used eight kinds of colored lenses and one lens that reflects blue light. Moreover, we evaluated the relationship between the protective effects of the lens and the transmittance of lens at 464 nm. Lenses of six colors, except for the SY, PN, and reflective coating lenses, strongly decreased the reduction in cell damage induced by blue LED light exposure. The deep yellow lens showed the most protective effect from all the lenses, but the reflective coating lens and pink lens did not show any effects on photoreceptor-derived cell damage. Moreover, these results were correlated with the lens transmittance of blue LED light (464 nm). These results suggest that lenses of various colors, especially deep yellow lenses, may protect retinal photoreceptor cells from blue LED light in proportion to the transmit-tance for the wavelength of blue LED and the suppression of reactive oxygen species production and cell damage. Hiromoto, K., Y. Kuse, K. Tsuruma, N. Tadokoro, N. Kaneko, M. Shimazawa, and H. Hara. 2016. 'Colored lenses suppress blue light-emitting diode light-induced damage in photoreceptor-derived cells', J Biomed Opt,	No change is needed.

			21: 35004.	
43.	Gutierrez , Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. EFFECTS OF BLUE LIGHT EMITTING DIODE IRRADIATION ON THE PROLIFERATION, APOPTOSIS AND DIFFERENTIATION OF BONE MARROW-DERIVED MESENCHYMAL STEM CELLS Aims: Blue light emitting diodes (LEDs) have been proven to affect the growth of several types of cells. The effects of blue LEDs have not been tested on bone marrow-derived mesenchymal stem cells (BMSCs), which are important for cell-based therapy in various medical fields. Therefore, the aim of this study was to determine the effects of blue LED on the proliferation, apoptosis and osteogenic differentiation of BMSCs. Methods: BMSCs were irradiated with a blue LED light at 470 nm for 1 min, 5 min, 10 min, 30 min and 60 min or not irradiated. Cell proliferation was measured by performing cell counting and EdU staining assays. Cell apoptosis was detected by TUNEL staining. Osteogenic differentiation was evaluated by ALP and ARS staining. DCFH-DA staining and γ-H2A.X immunostaining were used to measure intracellular levels of ROS production and DNA damage. Results: Both cell counting and EdU staining assays showed that cell proliferation of BMSCs was significantly reduced upon blue LED irradiation. Furthermore, treatment of BMSCs with LED irradiation was followed by a remarkable increase in apoptosis, indicating that blue LED light induced toxic effects on BMSCs. Likewise, BMSC osteogenic differentiation was inhibited after exposure to blue LED irradiation. Further, blue LED irradiation was followed by the accumulation of ROSproduction and DNA damage. Conclusions: Taken together, our study demonstrated that blue LED light inhibited cell proliferation, inhibited osteogenic differentiation, and induced apoptosis in BMSCs, which are associated with increased ROS production and DNA damage. These findings may provide important insights for the application of LEDs in future BMSC-	No change is needed.

			based therapies. Geiger P, Barben M, Grimm C, Samardzija M. Blue light-induced retinal lesions, intraretinal vascular leakage and edema formation in the all-cone mouse retina. Cell death & disease. 2015;6:e1985.	
44.	Gutiérrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. Nrf2 PROTECTS PHOTORECEPTOR CELLS FROM PHOTO-OXIDATIVE STRESS INDUCED BY BLUE LIGHT Abstract Oxidative stress plays a key role in age-related macular degeneration and hereditary retinal degenerations. Light damage in rodents has been used extensively to model oxidative stress-induced photoreceptor degeneration, and photo-oxidative injury from blue light is particularly damaging to photoreceptors. The endogenous factors protecting photoreceptors from oxidative stress, including photo-oxidative stress, are continuing to be elucidated. In this study, we evaluated the effect of blue light exposure on photoreceptors and its relationship to Nrf2 using cultured murine photoreceptor (661W) cells. 661W cells were exposed to blue light at 2500 lux. Exposure to blue light for 6 to 24 hours resulted in a significant increase in intracellular reactive oxygen species (ROS) and death of 661W cells in a time-dependent fashion. Blue light exposure resulted in activation of Nrf2, as indicated by an increase in nuclear translocation of Nrf2. This was associated with a significant induction of expression of Nrf2 as well as an array of Nrf2 target genes, including antioxidant genes, as indicated by quantitative reverse transcription PCR (qRT-PCR). In order to determine the functional role of Nrf2, siRNA-mediated knockdown studies were performed. Nrf2-knockdown in 661W cells resulted in significant exacerbation of blue light-induced reactive oxygen species levels as well as cell death. Taken together, these findings indicate that Nrf2 is an important endogenous protective factor	No change is needed.

			against oxidative stress in photoreceptor cells. This suggests that drugs targeting Nrf2 could be considered as a neuroprotective strategy for photoreceptors in AMD and other retinal conditions. Chen WJ, Wu C, Xu Z, Kuse Y, Hara H, Duh EJ. Nrf2 protects photoreceptor cells from photo-oxidative stress induced by blue light. Experimental eye research. 2017;154:151-8.	
45.	Rodríguez, Xabier, Universidad Complutense de Madrid, xabierro@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary opinion on potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. NON-VISUAL PHOTOPIGMENTS EFFECTS OF CONSTANT LIGHT-EMITTING DIODE LIGHT EXPOSURE ON THE INNER RETINA OF WISTAR RATS The retina is part of the central nervous system specially adapted to capture light photons and transmit this information to the brain through photosensitive retinal cells involved in visual and non-visual activities. However, excessive light exposure may accelerate genetic retinal diseases or induce photoreceptor cell (PRC) death, finally leading to retinal degeneration (RD). Light pollution (LP) caused by the characteristic use of artificial light in modern day life may accelerate degenerative diseases or promote RD and circadian desynchrony. We have developed a working model to study RD mechanisms in a low light environment using light-emitting diode (LED) sources, at constant or long exposure times under LP conditions. The mechanism of PRC death is still not fully understood. Our main goal is to study the biochemical mechanisms of RD. We have previously demonstrated that constant light (LL) exposure to white LED produces a significant reduction in the outer nuclear layer (ONL) by classical PRC death after 7 days of LL exposure. The PRCs showed TUNEL-positive labeling and a caspase-3-independent mechanism of cell death. Here, we investigate whether constant LED exposure affects the inner-retinal organization and structure, cell survival and the expression of photopigments; in particular we look into whether constant LED exposure causes the death of	No change is needed.

			retinal ganglion cells (RGCs), of intrinsically photosensitive RGCs (ipRGCs), or of other inner-retinal cells. Wistar rats exposed to 200 lx of LED for 2 to 8 days (LL 2 and LL 8) were processed for histological and protein. The results show no differences in the number of nucleus or TUNEL positive RGCs nor inner structural damage in any of LL groups studied, indicating that LL exposure affects ONL but does not produce RGC death. However, the photopigments melanopsin (OPN4) and neuropsin (OPN5) expressed in the inner retina were seen to modify their localization and expression during LL exposure. Our findings suggest that constant light during several days produces retinal remodeling and ONL cell death as well as significant changes in opsin expression in the inner nuclear layer. Benedetto MM, Guido ME, Contin MA. Non-Visual Photopigments Effects of Constant Light-Emitting Diode Light Exposure on the Inner Retina of Wistar Rats. Frontiers in Neurology. 2017;8(417).	
46.	Gutiérrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following aticle is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. THE IMPACT OF WAVELENGTHS OF LED LIGHT-THERAPY ON ENDOTHELIAL CELLS Low level light therapy receives increasing interest in the felds of tissue regeneration and wound healing. Several in vivo studies demonstrated the positive efects of LLLT on angiogenesis. This study aimed to investigate the underlying properties in vitro by comparing the efects of light therapy by light emitting diodes of diferent wavelengths on endothelial cells in vitro. Human umbilical vein endothelial cells were treated with either 475nm, 516nm or 635nm light. Control cells were not illuminated. 2D proliferation was quantifed by manual counting. HUVEC migration was analyzed by performing a 2D wound scratch assay and a 3D bead assay. The infuence of LLLT on early vasculogenic events was determined in a 3D fbrin co-culture model with adipose-derived stem cells.	Therapy is outside the scope of the current Opinion.

			Stimulation with both red and green pulsed LED light signifcantly increased HUVEC proliferation and 3D migration. Moreover, HUVEC showed increased 2D migration potential with green light stimulation. The treatment with blue light was inefective. Several parameters showed that green light was even more potent to stimulate proliferation and migration of endothelial cells than clinically well-established red light therapy. Further studies have to focus on intracellular mechanisms induced by diferent wavelengths in order to optimize this promising therapy in tissue regeneration. Rohringer S, Holnthoner W, Chaudary S, Slezak P, Priglinger E, Strassl M, et al. The impact of wavelengths of LED light-therapy on endothelial cells. Scientific reports. 2017;7(1):10700.	
47.	Rodríguez , Xabier, Universidad Complutense de Madrid, xabierro@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary opinion on potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. THE INVOLVEMENT OF THE OXIDATIVE STRESS IN MURINE BLUE LED LIGHT-INDUCED RETINAL DAMAGE MODEL The aim of study was to establish a mouse model of blue light emitting diode (LED) light-induced retinal damage and to evaluate the effects of the antioxidant N-acetylcysteine (NAC). Mice were exposed to 400 or 800 lx blue LED light for 2 h, and were evaluated for retinal damage5 d later by electroretinogram amplitude and outer nuclear layer (ONL) thickness. Additionally, we investigated the effect of blue LED lightexposure on shorts-wave-sensitive opsin (S-opsin), and rhodopsin expression by immunohistochemistry. Blue LED light induced lightintensity dependent retinal damage and led to collapse of S-opsin and altered rhodopsin localization from inner and outer segments to ONL. Conversely, NAC administered at 100 or 250 mg/kg intraperitoneally twice a day, before dark adaptation and before light exposure. NAC protected the blue LED light-induced retinal damage in a dose-dependent manner. Further, blue LED light-induced decreasing of S-opsin levels and altered rhodopsin localization, which	The paper is outside the scope of the current Opinion. No change of the Opinion is needed.

			were suppressed by NAC. We established a mouse model of blue LED light-induced retinal damage and these findings indicated that oxidative stress was partially involved in blue LED light-induced retinal damage. Nakamura M, Kuse Y, Tsuruma K, Shimazawa M, Hara H. The Involvement of the Oxidative Stress in Murine Blue LED Light-Induced Retinal Damage Model. Biological & pharmaceutical bulletin. 2017;40(8):1219-25.	
48.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	6.5. Eye optics fundamentals	P23L16. Recreational would be better word than avocational. P24L12. 410nm is violet, not blue. P24L22-23. Previous to what? Also suggested to change order of words for better clarity: … analysed the photobiological effect on white LED light exposure with CCT 2954K, 5624K and 7378K on human lens cells… P24L16-28. Re "a small additional contribution", this applies equally to other lighting, not just LEDs. The weighted exposures may be higher or lower for LEDs compared to other lighting types. The next paragraph shows how it depends on CCT, but gives the impression that this is something particularly to do with LEDs. This might lead to unintended decisions being made, if and when appropriate LEDs are the least bad option. P25L2-7. There is little support for the statement made that LEDs emit more blue light as they get older in absolute terms. Degrading phosphors would be expected to emit less as longer wavelength light and more as heat, but would not be expected to transmit more blue light (contrary to the statement made). Whilst the relative proportion of blue light increases as less longer wavelength light is emitted, the absolute amount of blue light may remain roughly the same. P25L14. Suggest apoptotic not apoptosis P25L8-38 (3rd and 4th paragraphs). These seem very	Text has been amended. Text has been amended. Text has been amended. No change in the text is required. No change is needed. Text has been amended.

			detailed (even long-winded) given how limited the evidence is. The study described in paragraph 3 seems internally quite inconsistent and could be put it in the category of preliminary work that doesn't justify much in the way of conclusions, so why waste so much effort on it? The study in the fourth paragraph must be of very limited relevance to human health given that it involves albino rats that are naturally nocturnal. Again, this is far too detailed for something that is simply not really relevant. P25L44. There is no reference to this standard in Section 8. P26L11. 100nm. UV shorter than 180nm is absorbed in air. How is the relevance of radiation <180nm? P26L28-35. There is no real evidence that any effects are due to LEDs, this section doesn't add anything at all. It is also not clear how negative impact on ocular health is not an adverse health effect? P27L4 calls for "lower" blue component LEDs for domestic lighting. This is a puzzling conclusion. Lower than what and when do we stop lowering it? Why just domestic lighting and not lighting in other buildings? If exposures are within the safety threshold and there are no adverse effects recorded and daylight exposure generally dominates, how would lowering it possibly help? Sections 6.6.2 and Section 6.6.3. There is a lot of overlap and repetition between these sections and within section 6.6.3; they should be combined into one. Thus, lines 23-35 are repetition of P28. These sections need substantial revision. P30L18-20. Suggest UV-B is carcinogenic to humans, however, and public health … to avoid saying UV-B is carcinogenic to humans and public health organizations	No change is needed. The reference list has been updated. Text has been amended. No change is needed. Text has been amended. Text has been amended. Text has been amended.
49.	Gutiérrez, Sara, Universidad Complutense de Madrid,	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic.	No change is needed.

	saracagu@ucm.es, Spain		EFFECTS OF BLUE LIGHT EMITTING DIODE IRRADIATION ON THE PROLIFERATION, APOPTOSIS AND DIFFERENTIATION OF BONE MARROW-DERIVED MESENCHYMAL STEM CELLS BACKGROUND/AIMS: Blue light emitting diodes (LEDs) have been proven to affect the growth of several types of cells. The effects of blue LEDs have not been tested on bone marrow-derived mesenchymal stem cells (BMSCs), which are important for cell-based therapy in various medical fields. Therefore, the aim of this study was to determine the effects of blue LED on the proliferation, apoptosis and osteogenic differentiation of BMSCs. METHODS: BMSCs were irradiated with a blue LED light at 470 nm for 1 min, 5 min, 10 min, 30 min and 60 min or not irradiated. Cell proliferation was measured by performing cell counting and EdU staining assays. Cell apoptosis was detected by TUNEL staining. Osteogenic differentiation was evaluated by ALP and ARS staining. DCFH-DA staining and γ-H2A.X immunostaining were used to measure intracellular levels of ROS production and DNA damage. RESULTS: Both cell counting and EdU staining assays showed that cell proliferation of BMSCs was significantly reduced upon blue LED irradiation. Furthermore, treatment of BMSCs with LED irradiation was followed by a remarkable increase in apoptosis, indicating that blue LED light induced toxic effects on BMSCs. Likewise, BMSC osteogenic differentiation was inhibited after exposure to blue LED irradiation. Further, blue LED irradiation was followed by the accumulation of ROS production and DNA damage. CONCLUSIONS: Taken together, our study demonstrated that blue LED	

			light inhibited cell proliferation, inhibited osteogenic differentiation, and induced apoptosis in BMSCs, which are associated with increased ROS production and DNA damage. These findings may provide important insights for the application of LEDs in future BMSC-based therapies. Yuan Y, Yan G, Gong R, Zhang L, Liu T, Feng C, et al. Effects of Blue Light Emitting Diode Irradiation On the Proliferation, Apoptosis and Differentiation of Bone Marrow-Derived Mesenchymal Stem Cells. Cellular physiology and biochemistry : international journal of experimental cellular physiology, biochemistry, and pharmacology. 2017;43(1):237-46.	
50.	Gutiérrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic: 2017_Serezhnikova_Age-Related Adaptive Responses of Mitochondria of the Retinal	Text has been amended. The reference list has been updated.
51.	Rodríguez, Xabier, Universidad Complutense de Madrid, xabierro@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary opinion on Potential risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. NUCLEAR FACTOR (ERYTHROID-DERIVED)-RELATED FACTOR 2-ASSOCIATED RETINAL PIGMENT EPITHELIAL CELL PROTECTION UNDER BLUE LIGHT-INDUCED OXIDATIVE STRESS. Purpose. It is a matter of increasing concern that exposure to light-emitting diodes (LED), particularly blue light (BL), damages retinal cells. This study aimed to investigate the retinal pigment epithelium (RPE) damage caused by BL and to elucidate the role of nuclear factor (erythroid-derived)-related factor 2 (Nrf2) in the pathogenesis of BL-induced RPE damage. Methods. ARPE-19, a human RPE cell line, and mouse primary RPE cells from wild-type and Nrf2 knockout (Nrf2-/-) mice were cultured under blue LED exposure (intermediate wavelength, 450 nm). Cell death rate and reactive oxygen species (ROS) generation were	No change is needed.

			measured. TUNEL staining was performed to detect apoptosis. Real-time polymerase chain reaction was performed on NRF2 mRNA, and western blotting was performed to detect Nrf2 proteins in the nucleus or cytoplasm of RPE cells. Results. BL exposure increased cell death rate and ROS generation in ARPE-19 cells in a time-dependent manner; cell death was caused by apoptosis. Moreover, BL exposure induced NRF2 mRNA upregulation and Nrf2 nuclear translocation in RPE. Cell death rate was significantly higher in RPE cells from Nrf2-/- mice than from wild-type mice. Conclusions. The Nrf2 pathway plays an important role in protecting RPE cells against BL-induced oxidative stress. Takayama K, Kaneko H, Kataoka K, Kimoto R, Hwang SJ, Ye F, et al. Nuclear Factor (Erythroid-Derived)-Related Factor 2-Associated Retinal Pigment Epithelial Cell Protection under Blue Light-Induced Oxidative Stress. Oxidative medicine and cellular longevity. 2016;2016:8694641.	
52.	Gutierrez, Sara, Universidad Complutense de Madrid, saracagu@ucm.es, Spain	6.5. Eye optics fundamentals	The following article is not included on the Preliminary Opinion on Potetintal risks to human health of Light Emitting Diodes (LEDs) and it contents important information about this topic. Retinal damage induced by commercial light emitting diodes (LEDs). Spectra of "white LEDs" are characterized by an intense emission in the blue region of the visible spectrum, absent in daylight spectra. This blue component and the high intensity of emission are the main sources of concern about the health risks of LEDs with respect to their toxicity to the eye and the retina. The aim of our study was to elucidate the role of blue light from LEDs in retinal damage. Commercially available white LEDs and four different blue LEDs (507, 473, 467, and 449nm) were used for exposure experiments on Wistar rats. Immunohistochemical stain, transmission electron microscopy, and Western blot were used to exam the retinas. We evaluated LED-induced retinal cell damage by studying oxidative stress, stress response pathways, and the	No change is needed.

			identification of cell death pathways. LED light caused a state of suffering of the retina with oxidative damage and retinal injury. We observed a loss of photoreceptors and the activation of caspase-independent apoptosis, necroptosis, and necrosis. A wavelength dependence of the effects was observed. Phototoxicity of LEDs on the retina is characterized by a strong damage of photoreceptors and by the induction of necrosis. Jaadane I, Boulenguez P, Chahory S, Carre S, Savoldelli M, Jonet L, et al. Retinal damage induced by commercial light emitting diodes (LEDs). Free radical biology & medicine. 2015;84:373-84.	
53.	Udovicic, Ljiljana, Federal Institute for Occupational Safety and Health, Friedrich-Henkel-Weg 1-25, D-44149 Dortmund, udovicic.ljiljana@baua.bund.de, Germany	6.5. Eye optics fundamentals	6.5.2.3 Posterior Segment of the Eye p. 25, line 8-10 "Irradiating human RPE cells in vitro with three different LED light sources - blue (468 nm), green light (525 nm), red-light (616 nm) or white light at an irradiance of 5 mW/cm2 induce a significant reduction of the viability of the cells for all four LEDs light (Chamorro et al., 2013)." It should be emphasized, that RPE cells in experiments of Chamorro et al. (2013) were exposed to such a high irradiance levels (5 mW/cm2) that the photochemical exposure limit value was exceeded. Those exposure levels do not have anything to do with LEDs as lighting components in screens of PCs.	No change is needed.
54.	HAnnevik, Merete, Norwegian Radiation Protection Authority, merete.hannevik@nrpa.no, Other	6.6. Skin optics fundamentals	p27 line 8. the deccription of the skin does not harmonize with figure 8 or with p29 line30 p29 line30 are the skin layers visible from the surface? p27 line 26 Replace the definiton of absorption with that of International Lighting Vocabulary: Process by which radiant energy is converted to a different form of energy by interaction With matter. Add to Chapter 9 Glossary and Terms.	Text has been amended

			p28, line 26 and 35 and other Places in section 6.6.2 and 6.6.3 should refer to penetration Depth as defined, not only penetration. p28 line 37-47 repetition	
55.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	6.6. Skin optics fundamentals	p. 29, line 1 (also applies to the definition listed in p. 54) : "Regular reflectance is the radiation that penetrates the skin and is scattered back later." Please note that "reflectance" is not a radiation but a dimensionless ratio of radiations. The reflectance described in the text does not match the traditional definition of regular (specular or mirror) reflectance, but rather that of the diffuse (scattered) one. Regular reflections obey the equal angles law of traditional geometrical optics. Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	Text has been amended.
56.	Asmuss, Monika, Federal Office for Radiation protection, masmuss@bfs.de, Germany	6.7 Optical radiation effects on skin	Chapter 6.7.2.: It is difficult to understand, how the conclusions in 6.7.3 (or any conclusion) could be drawn from the two controlled studies and two case reports. Essential information e.g. about the emitted spectra of the different sources or at least about the colour temperatur in Kelvin is missing. Some sources seem to emit visisible light, others UV, none of them infrared. How can the conclusions on IR-LEDs be drawn from these publications? p 32, line 18: the sentence "...effects due to excessively intense sources Close to the source.." seems to be wrong.	Text has been amended.
57.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	6.7 Optical radiation effects on skin	This section seems very detailed considering that most of the description doesn't really relate to LEDs, the reported effects of LEDs were extremely limited and there was insufficient information about the output of the LEDs anyway. Effects of UV on skin in general are	

			extensively and comprehensively addressed in recently published SCHENIR/SCHEER opinion documents. These documents are widely available and it is not clear why it should be repeated again here. Section 6.7.2.2. What can you really deduce from two idiosyncratic cases? 6.7.3 Conclusions It is not clear if conclusions could be reached at all from the preceding paragraphs other than that there is little evidence on which to base conclusions.	No change is needed. Text has been amended.
58.	Tosini, Gianluca, Morehouse School of Medicine, gtosini@msm.edu, Other	6.8 Circadian rhythms	I think this report under estimate the risk of LED for health. Many studies have shown that exposure to light and in particular on blue light at night has severe effects on human health and is co-factor in the development of several pathologies including metabolic diseases, cancer, etc. In addition the report is not considering the risk of LED exposure for children. Please see our recent review on this subject. Gianluca Tosini, Ph.D. Professor and Chair Department of Pharmacology and Toxicology Director Circadian Rhythm and Sleep Disorders Program Director Neuroscience Institute Morehouse School of Medicine 720 Westview Dr Atlanta, Ga 30310 phone: 404-7565214	Text has been amended for clarity.
59.	Hannevik, Merete, Norwegian Radiation Protection Autority, merete.hannevik@nrpa.no, Other	6.8 Circadian rhythms	p 32 line 27 Why is this Chapter so much longer and more detailed than other parts of the report? p34 line 16-20 Was the radiance/irradiance Levels different for the different light Sources? that is important information. p 34 line 33-35 Could it be that higher radiance screens have larger effect than low irradiance screens in the mentioned wavelength range and not LED	Text has been amended.

			contra CCFL? p 34 line 54-55. was the radiance/irradiance Level unknown, could the difference be due to different radiance Level and not only the spectral distribution? p35 line 5-6 Were the blue light Level of the white light Source comparable With the blue LED? p 35 line 12. Beneficial emission Spectrum - what kind of beneficial effect, should be commented? p 37 line 12-13 "when set to 50% of a dimmer switch" is very diffuse, and what does this tell us? What information do we get from fig 10? Does Figure 10 show the light emission, only voltage? Figure 11: It is many different LED and not all have these kinds in dining/Kitchen room? If it only refers to the study mentioned in line 12 that should be mentioned. It would be interesting to compare the Spectrum of different sources previously called white and blue LED rather than this example?	
60.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	6.8 Circadian rhythms	There's quite a lot on Circadian rhythms, considering that there seems to be relatively little hard evidence that LEDs produce different effects to other light sources; this could all be truncated quite a lot. P32L28 and 29. Delete our P32L45. The constant conditions for this require not just an absence of light cues, but a complete absence of any other cues. Both entrainment and phase shifting are possible without light cues. P33L27. Generally a good overview, but it is important to give correct credit: Melanopsin's presence in the (inner) retina (discovered [17] 19 years ago) led to the discovery of the photosensitivity of ipRGCs, not the other way around. Melanopsin, when it was discovered 19 years ago, it was as an opsin present in melanophores of the frog (hence its name). P33L50. Sunlight would be more appropriate in this	Text has been amended.

			context than daylight; daylight can be simulated artificial light. P33L51. What does aspects mean? P34L25-28. The comparison being made is not clear. Higher than what – i.e. to what does the 0.099 W/(sr m^2) relate? P36L15. Poorer sleep and negative health risks are very subjective, perhaps better to write changed sleep patterns and other adverse effects, and this might be more in keeping with other sections and lack of explicit data P35L16-37 There is an unaccountable difference in standards used to assess the results of two similar studies (Rangtell et al., 2016 and Chang et al., 2014). L19 says correctly of both studies no non-LED device control group was included; both used reading an ordinary book. The comment on L24 of Rangtell et al. that no control group was included relates to the bright light exposure rather than the screen (although this could be made much clearer). Both studies lacked a control group for the prior light exposure (Chang et al had a 30 minute dark-adaptation protocol, Rangtell et al a 6.5 hour bright light protocol), but this is only highlighted to criticise Rangtell et al. (despite a daytime prior bright light exposure being more realistic than dark adaptation before reading). Similarly, both studies used reading an ordinary book as a control group, but this is only highlighted in support of Chang et al. Moreover, Chang et al's positive results are promoted to the highest level summary, whereas Rangtell et al's negative results appear to have been suppressed – despite the latter being a more realistic scenario for translation to real-life. The conclusions in S6.8.6 specifically stress the importance of whether the effects of light on circadian rhythms from LED will persist in real life, which ignores that the purpose of the Rangtell et al protocol was to test this using a more realistic scenario.	
61.	Bará, Salvador, Universidade de	6.8 Circadian rhythms	p. 33, lines 41-42: "In summary, spectral sensitivity of the circadian system is a complex interplay of external	Risk management issues are not in the remit of the SCHEER.

	Satiago de Compostela, salva.bara@usc.es, Spain		and internal factors, and not yet completely understood." That being true, it should also be stressed that the spectral sensitivity of several relevant outputs of the circadian system is understood well enough as for allowing to adopt sensible recommendations on the use of artificial light at daytime and nighttime, and for implementing adequate prevention measures. p. 36, lines 20-21: "However, the current conclusion is based on a limited amount of studies, which were mostly performed in a laboratory setting." This statement is correct, but it should be stressed the fact that this limited (but steadily growing) number of studies provides a significant amount of convergent evidence on the role of artificial light at night as a relevant circadian disruptor with potentially important health consequences. Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	No change is needed.
62.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	6.8 Circadian rhythms	p. 36, l. 21-23: "An important question that remains is whether light from LEDs, and artificial light in general, present in indoor lighting and screens will have an effect on the circadian system in real life compared to natural light sources." Also applicable to p. 40 , l. 18-21: "However, it is recognised that the exposure of the general population to optical radiation from LEDs is likely to be insignificant compared with the exposure to natural light outdoors, but any additional health burden needs to be considered." And p. 40, l. 40-42: "An important question is whether optical radiation from LEDs, and artificial light in general, which is present in indoor lighting and screens will have an effect on the circadian system in real life compared to natural light sources." The Preliminary Opinion document seems to fail to	Text has been amended. Text has been amended.

			acknowledge that, concerning the circadian effects of the use of artificial light at night, the "natural light sources" that shall be used as a reference for comparing the exposure to artificial light are the Moon and the stars. Darkness is the "natural light outdoors" baseline at nighttime. Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	
63.	Mark , Steele, REEVU, mark.steele@reevu.com, United Kingdom	6.9 Temporal Light Modulation (Flicker)	My Concerns around a number of the NEW LED lighting system roll out Is in their ability to be weaponized. Pulse modulating light at determined rates can cause seizures and many other not well publicized detrimental biological effects. Psychotronic weapon systems and Warfare capability could be visited to communities across the EU due to the current hackable platforms and Wireless communication systems enablers of the what could be a criminal, terrorist or State sponsored attack to control condition or even kill those more susceptible in the community. Mind conditioning and control systems have already been developed and can be deployed without the knowledge either of the community under attack or its government.	No change is needed
64.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	6.9 Temporal Light Modulation (Flicker)	P37L5-L13. As noted in the summary, unperceived flicker may also have effects, as there are two low-pass filter mechanisms in the human visual system, so components of flicker at frequencies which are only excluded by the second filter still enter the nervous system via the outer retina. The effects of chronic exposure to this continual unperceived neural load do not appear to have been investigated. See Price, 2017 "Can the Adverse Health Effects of Flicker from LEDs and Other Artificial Lighting Be Prevented?", published online by LEUKOS on 28 April 2017. P37, Figure 10. Needs reference. Y-axis label is misleading, arbitrary units (au) would be better.	No change is needed. Reference added. Text has been amended.

			P37, Figure 11. This figure is irrelevant to flicker section. P38L8. What does normal rear lights mean?	No change is needed. Text has been amended.
65.	Portaels, Carl-Eric, LightingEurope, carl-eric.portaels@lightingeurope.org, Belgium	7. RECOMMENDATIONS FOR FUTURE WORK	Please find our comments enclosed. LE_WG_HCL_-_Response_to_SCHEER_Preliminary_Report_Consultation_-_20170915_-_FINAL_VERSION.pdf	See separate response.  CommentsLightingEurope.doc.docx
66.	Udovicic, Ljiljana, Federal Institute for Occupational Safety and Health, Friedrich-Henkel-Weg 1-25, D-44149 Dortmund, udovicic.ljiljana@baua.bund.de, Germany	7. RECOMMENDATIONS FOR FUTURE WORK	Recommendations for future work p. 40, line 15-18 "The current EN 62471 standard does not take account of population groups particularly sensitive to blue light, hence there are no specific recommendations for population groups whose natural mechanisms for filtering blue light are diminished (children, aphakics and pseudophakics)." Recommendations for exposure limit values to protect against adverse effects of optical radiation are established by ICNIRP (see also p. 9, lines 35-38), they are not based on standards (as for instance EN 62471). Suggested correction: ICNIRP guidelines do not take account of population groups particularly sensitive to blue light, hence there are no specific recommendations for population groups whose natural mechanisms for filtering blue light are diminished (children, aphakics and pseudophakics).	No change is needed.
67.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	8. REFERENCES	P43L2. It is CIE TN 008, and the reference is also slightly different, see: http://www.cie.co.at/index.php/Publications/Technical	The reference list has been updated.

			+Notes	
68.	Udovicic, Ljiljana, Federal Institute for Occupational Safety and Health, Friedrich-Henkel-Weg 1-25, D-44149 Dortmund, udovicic.ljiljana@baua.bund.de, Germany	9. GLOSSARY OF TERMS	Glossary of terms p. 51 Blue light hazard irradiance - irradiance, spectrally weighted with the blue hazard (W/m2) Correction: Blue light hazard action spectrum - irradiance, spectrally weighted with the blue light hazard action spectrum (W/m2)	Text has been amended.
69.	Udovicic, Ljiljana, Federal Institute for Occupational Safety and Health, Friedrich-Henkel-Weg 1-25, D-44149 Dortmund, udovicic.ljiljana@baua.bund.de, Germany	9. GLOSSARY OF TERMS	Glossary of terms p. 52 "Exposure limits: It is important to note that to define the exposure limits, experiments were carried out on rabbits and some monkeys, exposed acutely to optical radiation (with different wavelength). Fundus examination was performed and the toxicity limit was reached when a white lesion was observed on the retina. Then, when this limit was determined, a reduction factor (between 2 and 10) was added." Suggested explanation: Exposure limits are derived from experimentally determined damage threshold values with added reduction factors. Damage thresholds are reported as the ED-50, i. e. the dose which results in a 50 % probability of observing damage at some time after exposure (typically 1 - 48 hours). Uncertainty inherent in the damage threshold is compensated for by a reduction factor, the quotient between ED-50 and the exposure limit. Reduction factors of the ICNIRP guidelines vary between a value of two and two orders of magnitude, depending on wavelength, biological effect regarded, exposure duration, etc.	Text has been amended.
70.	Udovicic, Ljiljana,	9. GLOSSARY OF	List of Abbreviations	Changes have been made.

	Federal Institute for Occupational Safety and Health, Friedrich-Henkel-Weg 1-25, D-44149 Dortmund, udovicic.ljiljana@baua.bund.de, Germany	TERMS	p. 55-57 Some of those abbreviations were not used in the Preliminary Opinion at all (see for instance FED, LET, PMLE, POLA, RR, …).	
71.	BILLERET, Dominique, Toy Industries of Europe, dominique.billeret@toyindustries.eu, Belgium	ABSTRACT	This comment is made to the "abstract" section since chapter 2.1 "background" related to the mandate from the EU Commission sevices is not open for comments. we would like to highlight that the legal background from chapter 2.1 does not contain a reference to one of the particular safety requirements from the Toy Safety Directive (TSD) 2009/48/EC regarding LEDs. TSD Annex II chapter IV electrical properties contains the following: 8. Toys must be designed and manufactured in such a way that they do not present any health hazards or risk of injury to eyes or skin from lasers, light-emitting diodes (LEDs) or any other type of radiation. The European standard EN 62115 contains elaborated requirements for LEDs in toys. Compliance with this standard for LEDs is considered as a presumption of conformity to the corresponding TSD particular safety requirement.	No change is needed.
72.	Public Health England, , Public Health, marina.khazova@phe.gov.uk, United Kingdom	ABSTRACT	It is excellent that this type of review is undertaken, and the topic is certainly one where there is current need for it. Overall, it is a very good and important document that summarises a complex issue succinctly and expertly. The lack of explicit data is a problem but appropriate conclusions are made, nonetheless. It is important that the issues listed are both health and visual issues as these are often so closely related, it is right that they should be properly considered together, provided the intended scope is kept in mind. In this respect, the approach taken here should be commended, although there is a risk that not all relevant visual and health issues and mechanisms will	No change is needed. No change is needed.

			be included. For example: A. The association with the proportion of time under indoor lighting vs outdoor lighting and the progression of myopia is well-known but appears to have been overlooked or excluded. B. The blue light phototoxicity of split doses over repeated daily exposures may or may not be sufficiently protected against in the ICNIRP limits, see: Griess, G. A., and M. F. Blankenstein. "Additivity and repair of actinic retinal lesions." Investigative ophthalmology & visual science 20, no. 6 (1981): 803-807. C. Although Note B relates to exposures over several days, it refers to the acute effect. The chronic effects (e.g. Noell damage) are explicitly excluded from the ICNIRP guidelines, though there is an argument that this effect has not been experimentally reproduced in the original animal model for 50 years and may not be present in humans at all. D. Effects of blue light on acne and bilirubin. Adverse health effects should include not only effects due to the excess of blue light but due to its insufficiency, such as, for example, Seasonal Affective Disorder (SAD) which may be dominant in some vulnerable and susceptible population groups, in particular – elderly living in residential care. The document is also very long considering how little hard evidence there is in it and will benefit from substantial shortening. For example, it contains 11 page-long Annex III on optical radiation effects on skin, but no review of ocular effects, particularly – for visible and IR regions. Annex III is heavily skewed towards effects of UV on skin which were comprehensively addressed in recently published SCHENIR/SCHEER opinion documents. A previous SCENIHR report on EMFs gave a list of references that were not included in the evaluation	No change is needed. No change is needed. No change is needed. Medical therapy is outside the scope of this Opinion. No change is needed. No change is needed. No change is needed.

			(often with simple reasons for exclusion) to help guide the reader to better understand the decision making process. This opinion document has not done this and it would be worthwhile to include in Annex VII. It is also not clear how the inclusion of unpublished Personal Communication fits in with the selection criteria for this review. The inclusion of this type of evidence would allow for cherry-picking of scientific evidence and avoid scrutiny of peer-review process.	Text has been amended. Reference list has been updated.
			There is inconsistent use of italics throughout the document: et al is italicised but often other Latin words, such as in vitro, are not.	Text has been amended.
			There is inconsistent use of units: see, for example, kJ/m2 on lines 36 and 40 and mW/cm2 on line 44 of p68. SI units should be used throughout the text.	All units are in SI or SI derived and quoted from the original papers.
			Ageing (and variants) are also spelled aging.	Text has been amended.
			Glossary contains mainly physics and metrology terms (used for comparing LEDs). More terminology related to health/biology/pathology should be included, e.g., zeitgeber and chronotype, to make this more inclusive and useful.	The text has been amended.
			Command of English is variable and could benefit by some editing to improve clarity.	Text has been amended.
73.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	ABSTRACT	Abstract should include findings on flicker.	Text has been amended.
74.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	ABSTRACT	Abstract, lines 9-10 (also applicable to Section 6.8 Circadian rythms): "There is a low level of evidence that exposure to light in the late evening, including that from LED lighting and/or screens may have an impact on the circadian rhythm."	Text has been amended.
			The existing level of converging evidence on the role of LED sources and self-luminous displays as circadian	Text has been amended.

			rythm disruptors in the late evening seems to be enough relevant for deserving a deeper analysis. See, e.g. - Figueiro M, Overington D. Self-luminous devices and melatonin suppression in adolescents. Lighting Res. Technol. 2016; (48):966–975.Published online before print 6 May 2015, doi: 10.1177/1477153515584979., and references therein, and - Green A, Cohen-Zion M, Haim A, Dagan Y. Evening light exposure to computer screens disrupts human sleep, biological rhythms, and attention abilities. Chronobiology International, Published online: 26 May 2017. doi: 10.1080/07420528.2017.1324878 Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	
75.	Bará, Salvador, Universidade de Santiago de Compostela, salva.bara@usc.es, Spain	ABSTRACT	Abstract, lines 11-12 ((also applicable to Section 6.8 Circadian rythms): "At the moment, it is not yet clear if this disturbance of the circadian system leads to adverse health effects." Adverse health effects related to circadian disruption due to artificial light at night have been reported and should be discussed in depth in this Opinion. See, e.g.: - Cho YM, Ryu SH, Lee BR, Kim KH, Lee E, Choi J. Effects of artificial light at night on human health: A literature review of observational and experimental studies applied to exposure assessment, Chronobiology International 2015;32(9):1294-1310. doi: 10.3109/ 07420528.2015.1073158 - Hatori M, Gronfier C, Van Gelder RN, Bernstein PS, Carreras J, Panda S, Marks F, Sliney D, Hunt CE, Hirota T, Fukurawa T, Tsubota K. Global rise of potential health hazards caused by blue light-induced circadian disruption in modern aging societies. npj Aging and Mechanisms of Disease 2017; 3:9 ; doi:10.1038/s41514-017-0010-2 and references therein.	This is out of scope of the Opinion.

			Disclaimer: The opinions expressed herein do not have to be those of the Universidade de Santiago de Compostela, nor should they be identified as such.	
76.	Lincoln, John , LightAware, john@lightaware.org, United Kingdom	ABSTRACT	Page 2, Lines 8-9 The 'General Population' excludes young people and the elderly who make up over one-third of the EU population. This is misleading as it leads the reader to believe there are no adverse health impacts, while the draft report itself details many health impacts on young people the elderly and other vulnerable groups (Young people (0 to 14 years old) made up 15.6 % of the EU-28's population, older persons (aged 65 or over) had a 19.2 % share, and are projected to make up 27 % of the EU population by 2040. The report should also have considered demographic change and the health impacts on an ageing population.) Safety of light emitting diodes in toys, M P Higlett, J B, O'Hagan and M Khazova, February 2012, Journal of Radiological Protection, Volume 32, Number 1 Page 2, Lines 17 -19 Elderly people will experience 'discomfort' with LED systems – there is also good evidence that 'discomfort' will include headaches and migraines see "Flicker can be perceived during saccades at frequencies in excess of 1 kHz JE Roberts MSc and AJ Wilkins DPhil, Department of Psychology, University of Essex, Colchester, UK. Lighting Res. Technol. 2013; 45: 124-132." In addition, the elderly population are major users of public transport and will be disproportionately affected and disabled by blue LED displays, such as the destination displays quoted in the report and the general adoption of high colour temperature LED lighting within vehicles. Page 2, Lines 8 – 18 Although the abstract discriminates between the 'the general healthy population' and 'Vulnerable and	The issue of general population and vulnerable groups is sufficiently addressed in the Opinion. No change is needed. This is personal view. No change is needed.

			susceptible population (young children, adolescent and elderly people)' in the real world these groups occupy the same spaces, rendering the distinction arbitrary and meaningless. In addition, people who suffer from Chronic Migraines, Photosensitive Epilepsy and the wider group of people with light sensitivity are not included under Susceptible Groups. Page 2, Line 28 - 30 Cellular (Chamorro et al., 2013) and animal studies (Shang et al., 2014; Shang et al., 2017) and other information indicates that there are potential adverse health effects of LEDs. As LEDs are an emerging technology and available experimental data show potential harmful effects, further research is required to identify longer-term dose-response relationships.	Text has been amended These papers are already included in the Opinion and in the reference list. Further research has been already recommended in the Opinion.
77.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	ANNEX II The fundamental interaction between light and matter	P63L1. Why fundamental. Delete fundamental P63L20-25. Two very important parameters missing: pulse structure (e.g., number of pulses, duty ratio and time gap between pulses allowing cooling) and beam diameter. P64L34. If effects are dose (time x intensity) dependent, it should be short, higher radiance not lower radiance exposure P64L 42-47 and P64, Fig 13. The terms used in the text do not correspond in all cases to those in the figure. Should the excited triplet state (line 44) be T not S?	Text has been amended. Text has been amended. Text has been amended. Text has been amended.
78.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	ANNEX III Structure of the skin, Fitzpatrick skin type and optical radiation effects on skin	P67L18. hair not hairs P67, Table 4. Clear is not a colour, it is a measure of optical transparency. Why is the eye colour of Phototype I and II given as "clear"? P68L29-40. Irrelevant, delete	Text has been amended. Text has been amended.

			P69L20. Meaning of DermIS is not clear, reference not given	Text has been amended.
			P69L33. Delete squamous cell carcinoma and brackets as SCC already defined on line 20	Text has been amended.
			P70L19. Drying is generally removal of solvent and interchangeable use of dry/polymerise is incorrect. Also, this process may not be necessary for polymerisation. Suggest replacing dry (polymerise) with solidify.	Text has been amended.
			P70L22. Although these lamps are fluorescent lamps, they are NOT compact fluorescent lamps; delete compact	No change is needed.
			P71L41-43. Misleading. How could additional 1.1-1.5 MED (e.g., single half an hour work in midsummer) increase cancer risk?	No change is needed.
			P71L45. non melanoma needs a hyphen	Text has been amended.
			P72L16-P73L21 and P74-75,Table 5. Suggest deleting; it has been comprehensively summarised in two recently published SCHENIR/SCHEER opinion documents	No change is needed.
			P74, Table 5. Insert space between Poland and Switzerland	Text has been amended.
			P77, Table 6. Suggest delete Opinion: Health effects of artificial light	Text has been amended.
			P77L9. country not countries	Text has been amended.
79.	Hannevik, Merete, Norwegian Radiation Protection Authority, merete.hannevik@nrpa.no, Other	ANNEX IV Photometry and Radiometry	page 78 line 11 the formula is unreadable on my computer or printed	Text has been amended.
80.	Public Health England,, marina.khazova@phe.gov.uk, United Kingdom	ANNEX IV Photometry and Radiometry	P78L11. Equation has been corrupted, presumably in converting to pdf	Text has been amended.

			P78L46. ICNIRP need not be written in full here, already defined P79, Fig 19 caption. Include reference to the source of this figure	No change is needed. Text has been amended.
81.	Public Health England, marina.khazova@phe.gov.uk, United Kingdom	ANNEX V Generation of the circadian rhythm	P80L8. Transcription translation needs and or or P80L3-16. There is also published evidence of preserved circadian rhythms in isolated red blood cells which cannot contain a genetic clock. P80L27. tissue's gene expression is not elegant, suggest tissue's molecular processes P80L30-49. It is not clear of the relevance of this section to the Opinion document. How does it support evidence presented in this document? Suggest deleting P80L47. List of zeitgebers ignores the potential significance of conditioned stimuli (e.g. Amir and Stewart, 1996) in everyday life. P81L16. It would be more reasonable to change "circadian disturbance [sic] as might occur due to shift work" to "circadian [disruption] as is commonly caused by shift work". There is a consensus that certain types of shift work routinely cause circadian disruption, and there are established practices to minimize the circadian disturbance of shift work. IARC 2007's classification is based on the link between shift work that involves circadian or chronodisruption and cancer in humans, the link between shift work and circadian or chronodisruption was not in question. P81L22. Although it has been highlighted more than once in the reviewed literature, it has not been noted that the protocols of Chang et al., 2014 and Cajohen et al., 2011 do not readily translate to normal exposures and behaviours (only using screens after dark adaption, and prolonged periods of use).	Text has been amended. No change is needed. Text has been amended. No change is needed. No change is needed. Text has been amended. Text has been amended.

Comments received by email

No.	Name of individual/organisation	Table of contents	Submission	SCHEERs response
82.	Christopher Kyba +49 (0)331 288 28973 @skyglowberlin http://userpage.fu-berlin.de/~kyba/ Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ (GFZ German Research Center for Geosciences) Stiftung des öff. Rechts Land Brandenburg Telegrafenberg, 14473 Potsdam	Abstract Opinion, page 12, lines 14-16	I am writing to comment on the "SCHEER (Scientific Committee on Health, Environmental and Emerging Risks), Preliminary Opinion on Potential risks to human health of Light Emitting Diodes (LEDs), 6 July 2017." 1) The abstract states that: "There is a low level of evidence that exposure to light in the late evening, including that from LED lighting and/or screens may have an impact on the circadian rhythm." This is a dramatic understatement, and is undercut by the more correct and clearer statements in the document itself: "It has been shown that normal use of LEDs or screens illuminated by LEDs during the evening can perturb the circadian system influencing sleep quality, because of the high component of the short wavelength light (peak around 480 nm)." "In summary, the available studies indicate that white-light LEDs can have larger influence on the circadian rhythm compared to traditional light sources, due to their different spectral emission pattern." I believe that the abstract should therefore read: "There is evidence that exposure to light in the late evening, including that from LED lighting and/or screens may have an impact on the circadian rhythm." This is simply true, and adding "low level" undermines the evidence completely without justification. In addition, I find it surprising that the document makes no direct mention of breast cancer, for which there is a lot of evidence consistent with increased risk caused by melatonin reductions due to artificial light exposure (for example: http://onlinelibrary.wiley.com/doi/10.3322/caac.21218/full) 2) The abstract states "At the moment, it is not yet clear if this disturbance of the circadian system leads to adverse health effects." This is contradicted by the text in the full opinion: "Disturbances of our circadian rhythms have been linked with negative effects on health and increased accident risks. The biological clock is highly influenced by external light clues, including artificial light." 3) The document states: "For many people, exposure to natural optical radiation will predominate, i.e. exposure to optical radiation from LEDs is	Text has been amended. . Text has been amended. Text has been amended. Text has been amended. Text has been amended. No change is needed. No change is needed.

			likely to be insignificant compared with the exposure to natural light outdoors." This statement is not true during the hours when the sun is down. The document should be revised to refer to the daytime exposure. The meaning of "many" here is also unclear. Of course this is true for millions of people who work outdoors during the day, but "many" makes it sound as if this is the usual situation. However, the vast majority of people spend far more time indoors than outdoors, meaning that in terms of TIME (not integrated light), their main exposure will be to indoor light. See for example this paper: http://2012.experiencinglight.nl/doc/9.pdf The mean exposure for 8th graders and day shift nurses were both below 300 lux, which indicates that their light exposure was predominantly indoors. 4) The introductory text states "the full action spectrum for the influence of light on the circadian system is not completely clear yet as other wavelengths have an influence as well." This discussion of "other wavelengths" seems to underplay the role of short wavelength light. The statement in the full text is much more correct: "experiments have shown that, overall, circadian rhythms are more affected by short wavelength light (460-490 nm) (Duffy and Czeisler 2009, Benke and Benke 2013), with the exact peak probably dependent on the individual and context involved. 5) The text states on line 3, page 34 "during evening and night time, when naturally no light is present" This statement is incorrect, it should be perhaps read instead "when naturally less than 1 lux of light is present". There is a great deal of natural light available in evening and nighttime. Starlight is sufficient to walk safely along a path that is not overly obscured by trees. In the past, natural moonlight (around 0.1 lux) was used to allow the harvest to continue into the night (see e.g. Tess of the d'Ubervilles: "In the afternoon the farmer made it known that the rick was to be finished that night, since there was a moon by which they could see to work, and the man with the engine was engaged for another farm on the morrow.")	
83.	Professor Joan Roberts Joan E. Roberts, PhD Professor of Chemistry Department of Natural Sciences Room 813		Dear Dr. Meroni, I wasn't certain how to ask you to include this addition, so I have sent this to you directly. Besides the skin, the eye is the other organ that is potentially subjected to Drug Induced Phototoxicity.	Text has been amended and the reference list has been updated.

	Fordham University 113 West 60th Street New York City, NY 10023 jroberts@fordham.edu<mailto:jroberts@fordham.edu> 212-636-6323 FAX: 212-636-7217		I can add more but first I thought I would send you my review article from the International Journal of Toxicology. Please email me and let me know what additional information you might need	
84.	Salvador X. Bara Area de Optica, Dept. Fisica Aplicada. Facultade de Fisica / Facultade de Optica e Optometría Universidade de Santiago de Compostela Campus Sur, E-15782 SANTIAGO DE COMPOSTELA, GALICIA (Spain, European Union). E-mail salva.bara@usc.es Phone: +34-881813525 http://webspersoais.usc.es/persoais/salva.bara		Dear friends: I have uploaded several suggestions and comments to the 'Public consultation SCHEER Preliminary opinion on the potential risks to human health of Light Emitting Diodes (LEDs)'. Regarding privacy, I have stated that "*I do not object to publication of my contribution, including my personal data, on internet*". Please note that this refers to my written contributions, but not to the pdf copies of the scientific papers that were uploaded as requested. Most of these papers are from subscription journals and have external copyright. Forwarding them to the SCHEER working group is of course OK.	Note has been taken of this important disclaimer.