IEA 4E SSL ANNEX – 3RD TERM, TASK 1 WORK PLAN

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3rd Term Work Plan – Task 1

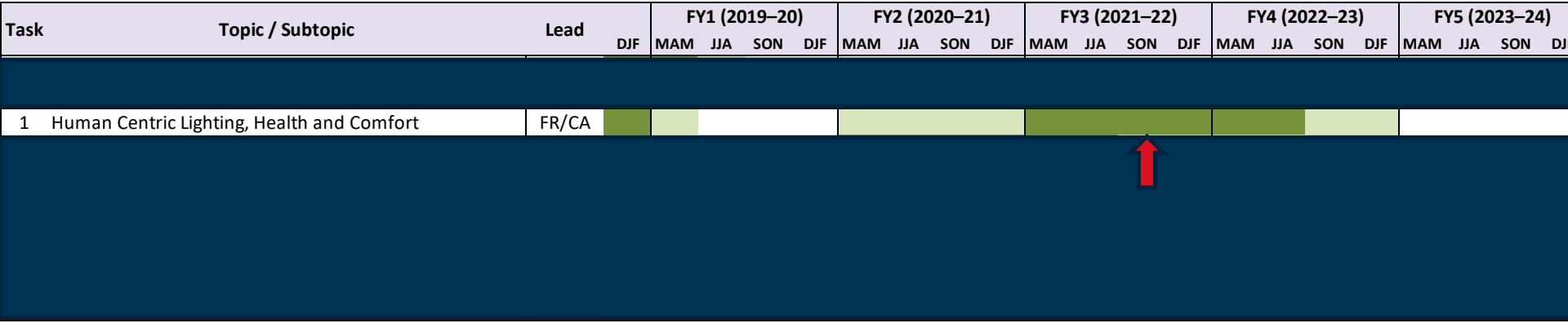
Objectives:

To study the health impacts on people of solid-state lighting, considering issues that concern both large fractions and small sensitive groups of the population.

Provide interpretation and guidance to policy-makers on setting appropriate requirements on health-related metrics for all forms of solid-state lighting.

“Official” planned schedule

Task	Topic / Subtopic	Lead	DJF	FY1 (2019–20) MAM	JJA	SON	DJF	FY2 (2020–21) MAM	JJA	SON	DJF	FY3 (2021–22) MAM	JJA	SON	DJF	FY4 (2022–23) MAM	JJA	SON	DJF	FY5 (2023–24) MAM	JJA	SON	DJ
1	Human Centric Lighting, Health and Comfort	FR/CA																					
Level of Effort:			90%	80%	85%	95%	95%	95%	95%	85%	85%	85%	85%	85%	85%	85%	85%	65%	65%	55%	55%	35%	20



Key:	
	More intense period of work by Task Leader and Experts
	Less intense level of effort, preparation or completion of work, mainly by Task Leader
DJF	December, January, February
MAM	March, April, May
JJA	June, July, August
SON	September, October, November

Description of work

Subtask 1: Completion of the study on Temporal Light Modulation (TLM) started in 2018 during the Annex 2nd term.

→ **Completed,** not discussed further.

Subtask 2: Detailed review of positive and negative health impacts of SSL. Update the health report published in 2014.

→ **In progress**, see next slides.

Subtask 2 : Update the 2014 Health Report

Health: broadly defined according to WHO (1948) definition: *Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*. (World Health Organization (WHO) 1948)

Do:

- Identify the psychological and physiological processes that light can affect, based on scientific evidence,
- Focus on areas where regulation or consumer advice might help to prevent adverse effects – identify how to identify products that work for people, or ways to apply them that will be beneficial (or avoid harm)
- Identify areas where metrics and test methods don't exist yet; but

Don't:

- Specify the lighting design choices that deliver the desired conditions. This is a review of the evidence not a guide to how to do lighting correctly.

Subtask 2: Revised Report scope (no changes)

- **Literature search will encompass light effects on health regardless of source (to capture relevant papers).**
- **Conclusions will focus on products: lamps & luminaires (both consumer and commercial) for general interior lighting; street lighting; with the caveat that these are products designed to emit white light.**
  - Focus on emissions (from products), but with commentary on exposures (products in use)
- **Out of scope: automotive, light sources that are not lighting products (e.g., battery powered: toys, portable lamps) and displays**
- **In general, the conclusions will address products in the Task 1 performance tiers,**
  - When used as intended in everyday applications;
  - Highlighting risks that could emerge if used incorrectly by consumers (where engineering controls don't apply);
  - Providing guidance relevant to sensitive populations;
  - Excluding exposures during manufacturing or installation.

Subtask 2 – Updated plan

2014 Report	Revision	Responsible team
Electrical safety	Out of scope, covered by existing standards. State this in Introduction	
EMF	Out of scope, covered by existing standards. State this in Introduction. This includes WiFi-enabled devices	
Glare	Yes, especially including new CIE report on UGR adaptation If possible, include subsection on identifying sensitive people & the conditions that cause problems for them	Christophe, with input from CSTB and ENTPE colleagues
Photobiological safety	Yes, but reduced length – no need to describe or derive action spectrum or risk categories (as was previously done) – being concise If possible, include subsection on identifying sensitive people & the conditions that cause problems for them	Christophe
TLM [formerly, flicker]	Yes If possible, include subsection on identifying sensitive people & the conditions that cause problems for them *LiFi / visible light communication?*	Jennifer
"Non-visual" effects	Yes **Part 1: circadian regulation; sleep; related medical (cancer, hormone…); physiological (cardiovascular, digestive, etc.)** **Part 2: mood; cognitive (vigilance, attention, etc.); well-being** If possible, include subsections on identifying sensitive people & the conditions that cause problems or that benefit them; Evaluate some product claims	Part 1: Sarah with Linda Part 2: Jennifer with Ashley
	Ecological effects of exterior lighting	Christophe leads, with support from Jennifer & Sarah
Conclusions	Draw the individual issues together to help to identify what a "good" product might be and identify how they might combine	

Subtask 2 – Literature Search Strategy

Common general strategy with specific outcome terms for each section

Part 1 – Lighting terms (IV)

Title & abstract: (“Light” OR lighting OR LED OR LEDs OR "solid state lighting" OR “light emitting diode” OR “fluorescent *” OR “incandescent *” OR “optical radiation” OR lamp OR luminaire)

AND

Title & Abstract: Section specific light terms – See TLM for example

Part 2 – Population/ Sample terms

AND

Title & Abstract: TBD

Part 3 – DV terms (by section)

AND

Title & Abstract: TBD

Part 4 – What we don’t want to include

AND NOT

Title & Abstract: “colour preference” OR “color preference”

Filters

Scopus

Year (2012 – 2021)

Language (French & English)

Document type (Article, conference proceeding, review)

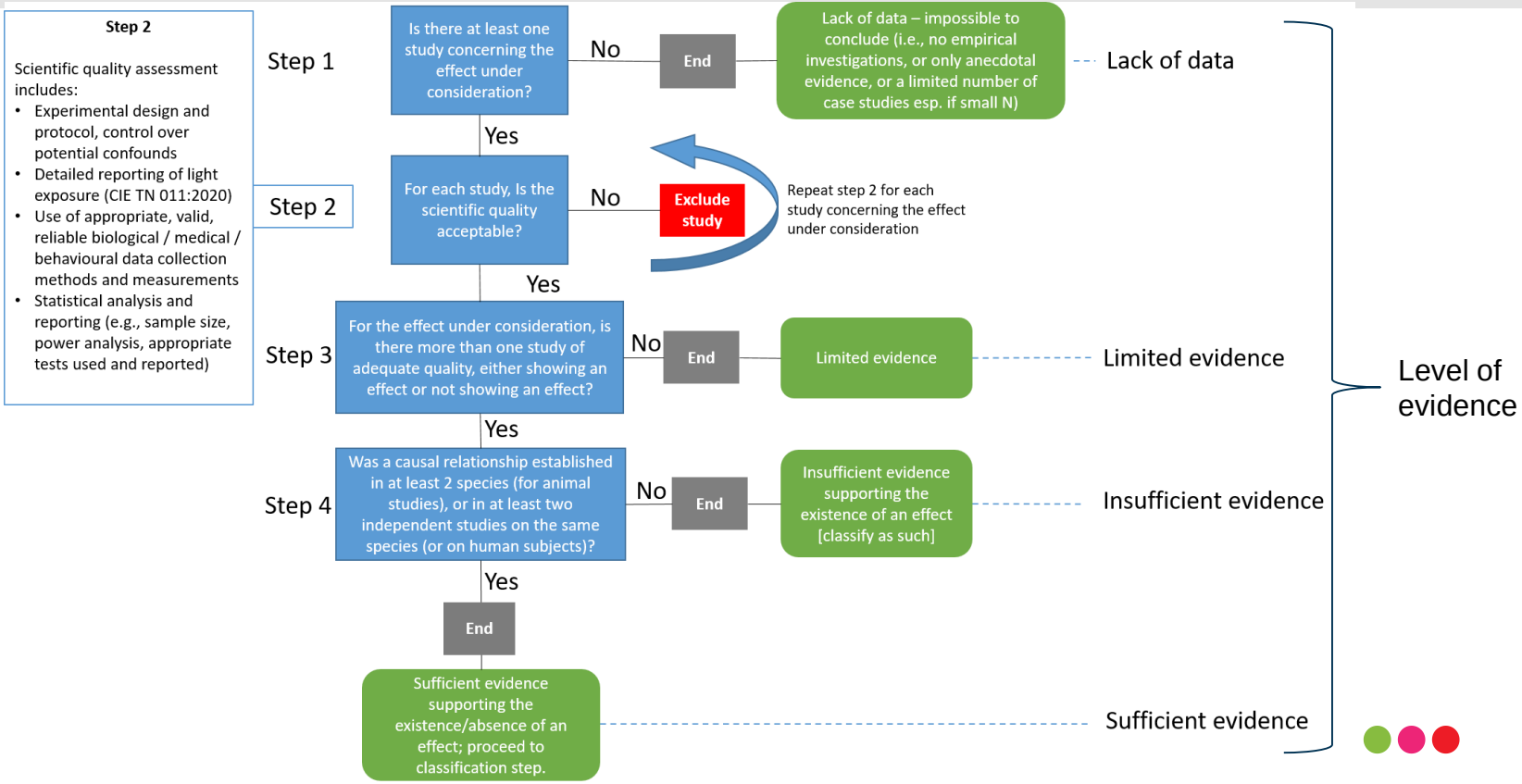
(**no** option to select human/animal studies as a filter)

Pubmed

Publication date (2012 – 2021)

Language (French & English)

Inclusion Flow Chart



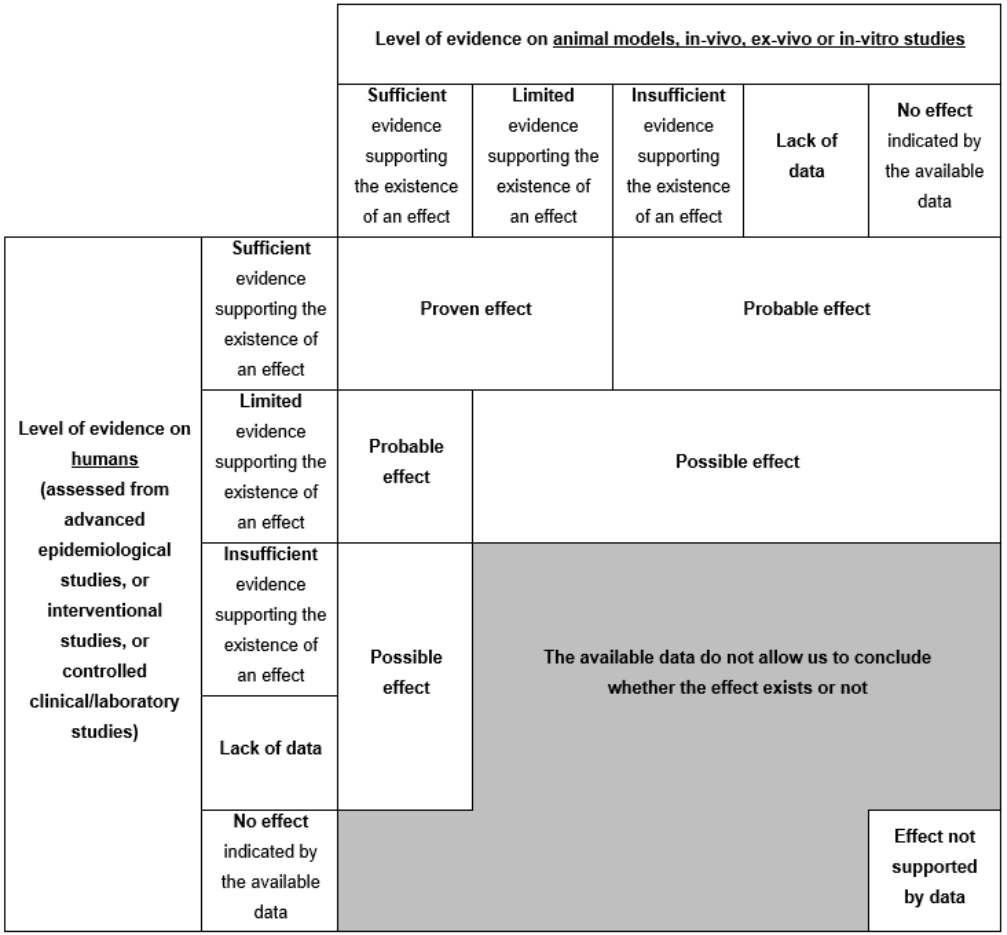
Effect categorization : Humans only

Procedure applicable to outcomes measured on humans: glare, headaches, visual performance, asthenopia, fatigue, mood, etc.

		Method of investigation on humans (adapted from Boyce 2021)				
		Observation: isolated case reports, anecdotal evidence, very small number of subjects	Basic epidemiology: Descriptive studies, ecological studies	Advanced epidemiology: case-control studies (retrospective), cohort/longitudinal studies (prospective)	Interventional studies: Field trials.	Laboratory or clinical studies: Randomized trials in a controlled environment
Level of evidence on humans	**Sufficient** evidence supporting the existence of an effect	Observation and basic epidemiology cannot provide evidence (causal proofs), only hints or correlations.		**Probable effect**	**Proven effect**	
	Limited evidence supporting the existence of an effect			**Possible effect**	**Probable effect**	
	Insufficient evidence supporting the existence of an effect	**The available data do not allow us to conclude whether the effect exists or not.**				
	Lack of data					
	No effect indicated by the available data	Observation and basic epidemiology cannot provide the evidence of "no effect"		**Effect not supported by data**		

Effect categorization: Animal + humans

Procedure applicable to outcomes measured on animal models and humans: retinal damage, sleep disruption, etc.



Level of Certainty for Classification

For each effect under consideration	
CLASSIFICATION	**LEVEL OF CERTAINTY**
Impossible to conclude	
Possible effect	
Probable effect	
Proven effect or Effect not supported by data	

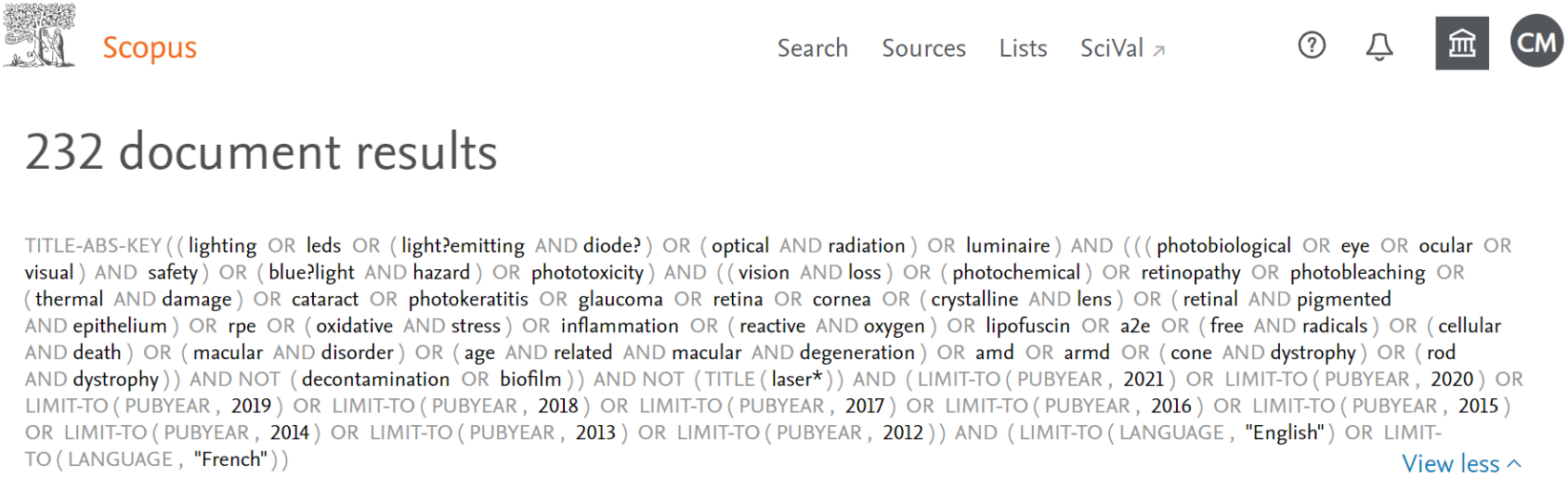
Search equation for Photobiological Safety (PBS)

Part 1 – Lighting terms (IV)
Title & abstract: light* OR LED OR (light?emitting AND diode?) OR (solid state lighting) OR (fluorescent light*) OR (incandescent light*) OR (optical radiation) OR lamp OR luminaire
AND
Title & Abstract: ((photobiological OR eye OR ocular OR visual) AND safety) OR (blue?light hazard) OR phototoxicity
Part 2 – Population/ Sample terms
AND
Title & Abstract:

Sensitive populations (better not include them in search strategy)
Pre-existing conditions:
Retinal disease
RPE disease
Macular disorder
Age related macular degeneration (AMD, ARMD)
dystrophy of the photoreceptors, cone dystrophy, rod dystrophy
Aphakic, pseudophakic
lens implant
Age:
Children, Infant, adolescent, Elderly
Part 3 – DV terms (by section)

AND
Title & Abstract :
(vision loss) OR photochemical OR retinopathy OR photobleaching OR (thermal damage) OR cataract OR photokeratitis OR glaucoma OR retina OR cornea OR (crystalline lens) OR (retinal pigmented epithelium) OR RPE OR (oxidative stress) OR inflammation OR (reactive oxygen) OR lipofuscin OR A2E OR (free radicals) OR (cellular death) OR (macular disorder) OR (age related macular degeneration) OR AMD OR ARMD OR (cone dystrophy) OR (rod dystrophy)
Part 4 – What we don't want to include terms
AND NOT
Title & Abstract: decontamination OR biofilm OR laser

Search equation for Photobiological Safety (PBS)



Results of search equation Photobiological Safety (PBS)

Database	SCOPUS
Search date	Updated 11 Oct 2021
Time period covered by search	2011 to Sep. 2021
Identified from databases	232
Excluded (not relevant)	174
Identified from other sources	5
Relevant	63

Excluded papers:

- Biology, medical and ophthalmology papers on retinal pathologies **unrelated to exposure to LEDs**.
- Articles on **blue light filters** and **intraocular (IOL) implants** with blue light filters.
- **Exposures not reflecting general lighting**: automotive headlights, medical treatments using light (photobiomodulation for instance), displays, screens, billboards, smartphones.
- **Luminaire design**, optical design, electrical engineering aimed to improve PBS.
- **Metrology**, measurement techniques of PBS.

Topics of included papers
Photobiological Safety (PBS)

Thematic categories	Number of references
Biology, medical and ophthalmology papers on ocular phototoxicity from blue light, LEDs, lamps or luminaires. In-vivo and ex-vivo animal studies (rat, mice, etc.) : 19 papers In-vitro studies (light interactions with retinal cells) : 7 papers	26
Considerations and critics of animal models used in phototoxicity experiments	2
Considerations about exposure limit values	2
Emission or exposure data of LED lamps and luminaires	12
Review papers	16
Collective health appraisal reports	3 reports 2 papers

Search equation for Glare

Part 1 – Lighting terms (IV)
Title & abstract: light* OR LED OR (light?emitting AND diode?) OR (solid?state lighting) OR “fluorescent light*” OR “incandescent light*” OR “optical radiation” OR lamp OR luminaire
AND
Title & Abstract: glare
Part 2 – Population/ Sample terms
AND
Title & Abstract:

Sensitive populations (better not include them in search strategy)
Pre-existing conditions:
Age: Children, Infant, adolescent, Elderly

Part 3 – DV terms (by section)
AND
(disability OR discomfort) OR scotoma OR {after-image} OR {post-image} OR dazzle OR {dry?eye} OR accommodation OR migraine OR headache OR paroxysmal)
Title & Abstract :
Part 4 – What we don’t want to include terms
AND NOT
Title & Abstract: photovoltaic OR glazing OR window OR fa?ade OR shading OR laser

Search equation for Glare

Scopus

Search Sources Lists SciVal ↗

192 document results

TITLE-ABS-KEY (({light source} OR lighting OR led OR leds OR {solid state lighting} OR {light emitting diode} OR fluorescent OR incandescent OR {optical radiation} OR lamp OR luminaire) AND glare AND (disability OR discomfort OR scotoma OR {after-image} OR {post-image} OR dazzle OR {dry-eye} OR accommodation OR migraine OR headache OR paroxysmal) AND NOT (laser OR photovoltaic OR glazing OR window OR fa?ade OR shading)) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012)) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "French"))

View less ^

Results of search equation: Glare

Database	SCOPUS
Search date	Updated 11 Oct 2021
Time period covered by search	2011 to Sep. 2021
Identified from databases	192
Excluded (not relevant)	138
Identified from other sources	
Relevant	54

Excluded papers:

- Glare of **image sensors**
- Glare from **daylight**
- **Glare tests** used in optometry
- **Glare filters** / colored glasses / photochromic glasses
- **Luminaire design**, optical design to minimize glare
- **Visual ergonomics**, rating of luminous environments (not about products)
- Glare from **other sources of light**: medical procedures using light, automotive headlights, traffic signals, billboards, computer vision syndrome, etc.
- **Metrology**, measurement methods of glare
- Computation of **glare metrics**, generic models

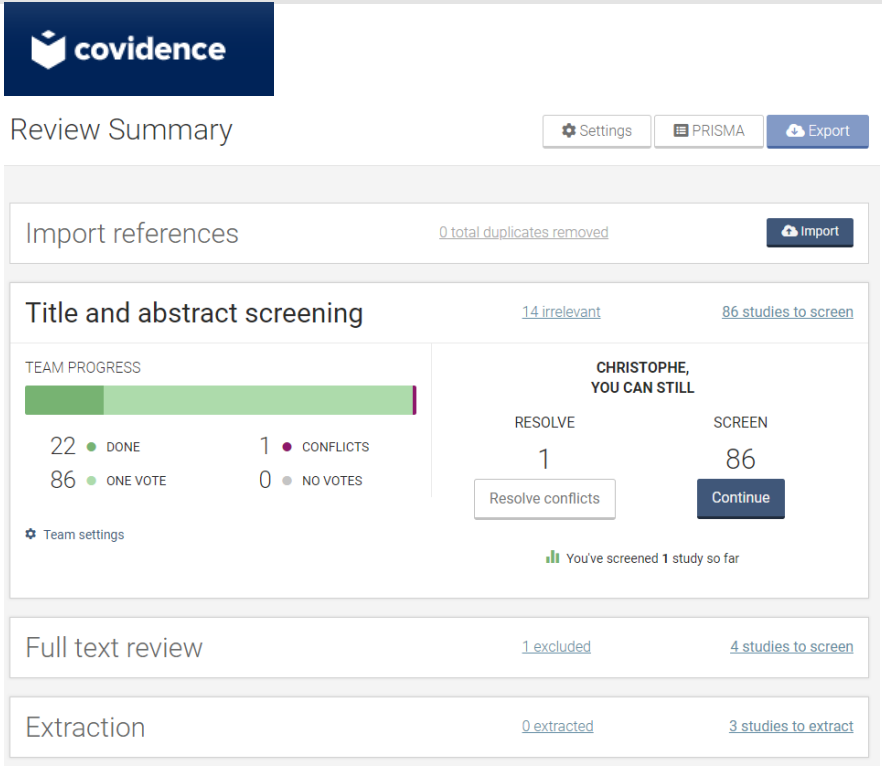
Topics of included papers
Glare

Thematic categories	Number of references
Health effects of glare (muscular troubles, eye symptoms, migraine)	3
Spectral and color sensitivity	8
Non-uniform sources, multiple sources, moving sources, small sources	10
Discomfort glare with indoor lighting SSL products	4
Discomfort glare with outdoor lighting SSL products	7
Age factor in disability and discomfort glare	4
Glare and timing considerations	4
Physiological response to glare: pupil size, eye opening, eye movements, bio-signals	9
Review papers	5
Collective health appraisal reports	7

Systematic review management

Covidence will be used to review, share and manage all the scientific papers.

- Access provided by NRC
- Removes article duplicates
- Keeps track of reasons for excluding
- Keeps track of the review progress by team member & study stage (title abstract vs full-text review)
- Generates a PRISMA flow diagram



New Team Members

Canada: Ashley Nixon

PhD Student at the University of Ottawa and part-time student employee at the NRC

Current work centres around the interplay between sleep/circadian rhythms, well-being, and light

Australia: Linda Shen PhD

Research Fellow at the Sleep and Circadian Medicine Laboratory at Monash University

Current work includes examining light exposure, biomathematical modelling and personalised interventions for improving performance and wellbeing in shift workers across multiple industries

Subtask 2: Work plan (updated October 2021)

2019

Refine list of review topics, Develop review criteria; Assign topics to leaders.
Done, revised plan shown here.

Jan 2020 to Dec 2021

Literature search, develop databases; Review key papers, inter-compare reviewing results; Refine criteria; Continuous coordination with CIE & ISO committees; continue reviewing & developing recommendations.
In process, but a bit delayed.

March 2022 to Aug 2022

Writing report.

Aug 2022 to Dec 2022

Internal review of report by annex members and management committee

Rounds of corrections

Subtask 2: External context – slow movement

ISO/TC 274/JWG 4 and CIE JTC 14 – Integrative lighting

ISO/CIE TR 21783 expected publication fall 2020 – ISO final ballot concluding soon.
[J. O'Hagan, convenor; J. Veitch is an expert member]

Illuminating Engineering Society – Light and Human Health committee

Draft document under revision
[J. Veitch & J. O'Hagan are members; J. Veitch has authored sections.]

Underwriters Laboratories

Design Guideline: UL 24480 - Design Guideline for Promoting Circadian Entrainment with Light for Day-Active People published December 2019

Design guidance on one aspect of the topic; its development and contents don't represent international expert consensus

Subtask 2: External context - public

Consumer groups concerned about LED lighting exist, e.g.

https://www.softlights.org/

The Annex report will co-exist with their online material.