Energy-Saving Lamps & Health

Source document:
SCENIHR (2008)

Summary & Details:
GreenFacts (2009)

Level 2 - Details on Energy-Saving Lamps & Health

The answers to these questions are a faithful summary of the scientific opinion produced in 2008 by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR): *"Light Sensitivity"*

The full publication is available at: http://copublications.greenfacts.org/en/energy-saving-lamps/ and at: http://ec.europa.eu/health/opinions/en/energy-saving-lamps/

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- Level 3 consists of the Source document, the internationally recognised scientific opinion which is faithfully summarised in Level 2 and further in Level 1.

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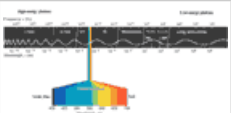
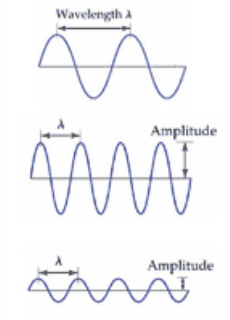
1. Introduction - What is light?



The electromagnetic spectrum
[see Annex 1, p. 10]

Light is electromagnetic radiation which is visible to the human eye. Electromagnetic radiation is generated by the oscillation or acceleration of electrons or other electrically charged particles. The energy produced by this vibration travels in the form of electromagnetic waves. These waves are characterised by their wavelength (λ) which is the distance between successive peaks and is measured in units of length, and by their intensity, or amplitude, which is the height of each of those peaks.



Wavelength and amplitude
[see Annex 2, p. 10]

To explain how light travels, it is considered a wave. However, **light can also be considered particles** when describing how it interacts with matter.

These particles called photons carry each a specific amount of energy. Light intensity increases with the number of photons. For example, intense red light used on a theatre stage and a traffic red light may consist of photons of the same energy but the first one is more intense due to the larger number of photons emitted.

Electromagnetic radiation extends from gamma rays (γ) through to long radio waves. This is often referred to as 'the **electromagnetic spectrum**'. The energy of a wave depends on its wavelength: the longer the wavelength, the lower the energy. Therefore, in the electromagnetic spectrum, gamma rays have the highest energy, and long radio waves the lowest.

The sun emits visible light, but also **infra-red (IR)** and **ultra-violet (UV)** radiation.

The visible part of the electromagnetic spectrum only covers a small range of wavelengths, from 380 nm to 750 nm. In the electromagnetic spectrum, shorter wavelengths (from 10 nm to 380 nm) are ultraviolet (UV) and longer wavelengths (from 750 nm to 1 mm) are infrared (IR) radiation. Ultraviolet radiation carries more energy and infrared radiation less energy than visible light.

According to the wavelengths, the ultraviolet portion of the spectrum is further divided into: UVA (315 – 400 nm), UVB (280 – 315 nm) and UVC (100 – 280 nm). All radiation from the sun with a wavelength below 290 nm, that is most high-energy UV-radiation, is filtered out by the atmosphere before reaching the Earth's surface.

2. How does light, infrared and UV radiation interact with skin and eyes?

Interaction with skin and eyes depends on the wavelength of the radiation
Source: GreenFacts

Light is essential to life on Earth and affects humans and other living organisms in various ways. The interaction of light with our skin and eyes influences our perception of warmth and cold. The changes in the level and colour of light throughout the day and across different seasons help the body regulate periods of rest and activity.

The way electromagnetic radiation interacts with matter depends on its wavelength and therefore its energy. Radiation of short wavelength (below 200 nm, such as UVCs) has high energy and can set off damaging chemical processes in living cells. If DNA is damaged in this way, it can lead to mutations and potentially induce cancer. Radiation of longer wavelength is usually harmless, although it can warm up the tissue exposed.

When radiation reaches the skin or the eyes, it can be reflected or it can penetrate the tissue and be absorbed or scattered in various directions. The fate of this radiation in the body depends on its wavelength:

- **Visible** light is usually scattered and is only strongly absorbed by some components such as pigments and blood. Pigments in specialized cells in the eye absorb visible radiation, triggering an electrical signal that travels through the optical nerve to the brain and allows us to see in colour.
- **Infrared radiation** is not scattered but strongly absorbed by water – the main constituent of soft tissues – and this causes a heat sensation when the skin is exposed to sunlight.
- Most **ultraviolet radiation** does not penetrate further than the upper layers of the skin (epidermis) as the human tissue absorbs the radiation very strongly. Although ultraviolet radiation has some beneficial effects such as helping production of vitamin D, in general it is considered to be harmful. This is because the absorbed energy not only produces heat but can also drive chemical reactions in the body. Most of these reactions are harmful and cause direct or indirect damage to proteins and DNA in the skin and eyes. Our skin is well adapted to the harmful effects of ultraviolet radiation and the damaged molecules and cells are usually repaired or replaced. Some people are particularly susceptible to ultraviolet and become sunburned even after extremely low exposures. Others show abnormal allergy-like skin reactions.

3. How do fluorescent lamps work?

Fluorescent lamps are made of a glass tube filled with a low pressure mixture of gases, specifically mercury and noble gases like argon, neon, xenon and krypton. The tubes are coated on the inside with a fluorescent material, usually a compound containing phosphorous. When the current is switched on, the starting mechanisms at each end of the lamp produce electrons that excite the gases inside the tube and make them release ultraviolet radiation. The ultraviolet radiation hits the fluorescent coating and this produces light.

Different chemical coatings are used to produce light of different colours. For instance, lamps can be designed to produce light that contains more blue light than conventional incandescent lamps, and therefore simulate daylight better. Fluorescent tubes can have either a single or a double glass envelope, which dramatically reduces the amount of UV radiation emitted since glass is an effective UV-filter.

Older lamps had starting mechanisms that often failed before the lamp did, which required frequent replacing of the lamps. They also had other shortcomings: they made a humming noise, flickered and were not sufficiently energy-efficient. All these deficiencies were eliminated in compact fluorescent lamps (CFLs) through an improved design of the starting mechanism.

The ionisation that excites the gases inside fluorescent lamps is not a concern to health since it only takes place inside the lamp. However, some ultraviolet radiation produced can diffuse through the protective glass envelope. The lamp coating and the glass cover affect the amount and the type of ultraviolet radiation released but in general, CFLs can emit more ultraviolet radiation and a higher proportion of blue light than incandescent lamps. For instance, someone sitting 20 cm away from certain CFLs with a single glass envelope can receive ten times more UVB than if the lamp was incandescent.

Most electric appliances generate electric and magnetic fields of low frequency. CFLs emit electromagnetic fields of both low and intermediate frequency although the exact range depends on the type of lamp. Little is known about the strengths of these fields.

As electricity through the power grid is in the form of alternating current, the intensity of the light produced by any lamp connected to it varies cyclically, depending on the frequency of the power grid. If this change in light intensity is perceived by the human eye, then this is defined as flicker. Flicker is virtually unnoticeable in incandescent lamps but can be quite pronounced in fluorescent lamps, particularly older or defective ones. Modern fluorescent lamps including CFLs have been designed to reduce this effect considerably and are therefore called "flicker free".

4. Can fluorescent lamps worsen health conditions not related to the skin?


Flicker can induce migrane
Source: Bob Smith

There have been claims that some non-skin conditions are aggravated by fluorescent lamps. However, such claims are often not supported by scientific evidence. In some cases, evidence does show a link between one of the properties of fluorescent lights and a health condition. The concerns have been attributed to different characteristics of energy-saving compact fluorescent lamps (CFLs), namely flickering and the ultraviolet radiation, electromagnetic fields and blue light they produce. More research is needed to reach final conclusions about several of the conditions mentioned below.

a) Epilepsy

Regular or repetitive visual patterns such as bold designs, flashing or flickering lights trigger seizures in 5 out of 100 epileptic people. This particular form of epilepsy is called **photosensitive epilepsy**. There is no scientific evidence that fluorescent tubes induce seizures, except for outdated or faulty, flickering, lamps. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#aa]*

b) Migraine

Visual stimuli are linked to migraine. For instance, high contrast striped patterns or flickering lights can trigger attacks. People with migraines and headaches can be particularly sensitive to light both during and between attacks. There is no scientific evidence that flicker from fluorescent lamps aggravates symptoms. However, some patients report that their migraine is aggravated by blue light from those lamps. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ab]*

c) Dyslexia and Irlen-Meares

These **learning disabilities** result in difficulties with reading and spelling. Evidence indicates that flicker from fluorescent lamps is not a problem as those suffering from this disease have an impaired sensitivity to flickering and moving visual stimuli. Some patients report that the condition is aggravated by ultraviolet and blue light emitted by cool white tubes. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ac]*

d) Ménière's disease

This disorder of the inner ear causes vertigo, hearing loss and ringing in the ears. The attacks are not related to light conditions but may be aggravated by flicker. A recommendation for vertigo is to provide an alternative to fluorescent lighting.

e) HIV/AIDS

Flickering light has no harmful effects on HIV-positive people, except those with retinal damage. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ae]*

f) Retinal diseases

Blue light can damage the eye, particularly for people with retinal diseases. There is also some evidence that prolonged exposure to blue light can make healthy retinas less sensitive to colour. For patients with such diseases it is therefore recommended to use filters to protect lens and retina. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#af]*

g) Autism

Although there is no evidence that fluorescent light has any negative effects on people with autism, an influence cannot be completely ruled out. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ag]*

h) Chronic Fatigue Syndrome

The effects of light on people with this and other related conditions are contradictory and there is no evidence for a link with fluorescent lighting. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ah]*

i) Fibromyalgia

Light conditions do not play a role in this disorder that causes muscle pain and fatigue. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ai]*

j) Dyspraxia

There is no evidence that light conditions have any effects on this coordination disorder. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#aj]*

k) Photophobia

People suffering from photophobia experience eye discomfort in bright light. Effects of CFLs have not been investigated, but cannot be ruled out. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#ak]*

l) Snow blindness and cataract

Usually, fluorescent light does not cause snow blindness (sunburn of the eyeball) or cataract. Only some commercially available CFLs emitting traces of UVC and significant amounts of UVB could in principle cause cataract and snow blindness if positioned at eye level for an extended period of time. Therefore fluorescent lamps used for room illumination cause neither snow blindness nor cataract. This holds for CFLs, provided that UVC and UVB radiation

are adequately filtered out. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#al]*

m) Electromagnetic hypersensitivity

See also our publication on EMF [see http://ec.europa.eu/health/opinions2/en/electromagnetic-fields/index.htm]

Some people claim to be very sensitive to electromagnetic fields generated by many electrical devices. Symptoms include reddening, tingling and burning sensations, headache, fatigue, dizziness, concentration difficulties and nausea. There is no demonstrated relation between the symptoms of these people and short-term exposure to electromagnetic fields but there are few studies on the effects of long-term exposure. CFLs generate electromagnetic fields but these are much weaker that those generated by other electric devices. At present, there is no evidence that electromagnetic fields from CFLs cause any symptoms or diseases. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/4-cfl-non-skin-diseases.htm#am]*

5. Can fluorescent lamps affect people with skin conditions?

Lamps used close to the skin could cause problems for people who are extremely light-sensitive
Source: Simon Cataudo

Fluorescent light could be a risk factor for several skin conditions that are brought on or aggravated by exposure to light.

a) Idiopathic photodermatoses

These are skin conditions (dermatoses) triggered by light (photo) that have no known cause (idiopathic). However, they are believed to involve the immune system, and include:

- Polymorphic Light Eruption: a condition causing itchy rashes on skin exposed to sunlight. It is worse in the summer and more common in countries far away from the Equator and at high altitudes.
- Chronic Actinic Dermatitis: a condition making the skin abnormally sensitive to UVA/UVB and, often, to visible radiation as well. Skin reactions are similar to those of contact allergy.
- Actinic Prurigo: an uncommon condition causing itchy skin eruptions that particularly affects American Indians and less frequently Caucasian and Asian populations; and women more than men.
- Solar Urticaria: an uncommon skin disorder mainly caused by exposure to UVA, although sometimes also by UVB and visible radiation. Symptoms are itchy, swollen, red areas on the skin.

The most severe cases of these diseases may potentially be at risk from CFLs.

More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#aa]

b) Drug-induced photosensitivity

Many drugs cause skin problems and allergic reaction when taken in combination with exposure to sunlight, and light in general. The reactions depend on the drug and include burning, prickling sensations, itching, blistering and reddening of the skin. CFLs are unlikely to be a problem because in many cases only UVA triggers the symptoms and large amounts of drug are needed to produce any effect.

- Two drugs (Photofrin and Foscan) used to treat cancers can cause skin reactions in patients exposed to visible light. However, this side-effect is well-known and

patients are closely managed. Therefore, in practice, CFLs are unlikely to constitute a significant problem.
- Psoralen, a natural substance present in several plants and foodstuffs (in celery, parsnip, limes), can cause skin inflammation if UVA exposure follows skin contact. Given the small amounts of psoralen in the diet, CFLs are unlikely to cause any problems.
- Some creams, such as sunscreen, used together with exposure to small doses of UVA can cause allergic reactions in susceptible individuals. However, CFLs are unlikely to cause any reactions.

More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#ab]

c) Genophotodermatoses

These are hereditary ("geno", relating to genes) skin diseases (dermatoses) triggered by light (photo). Although they are quite rare and not well understood, patients are advised to avoid unfiltered fluorescent light, including single-envelope CFLs. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#ac]*

d) Porphyrias

This group of rare skin diseases are caused by the accumulation of a type of pigment sensitive to light (porphyrin) within the skin and by a mixture of inherited and environmental factors. Extremely sensitive patients could possibly be at a slightly higher risk from CFLs compared to incandescent sources. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#ad]*

e) Eczema

Sunlight seems to worsen a form of eczema (atopic eczema) in about one in ten patients. It seems unlikely that CFLs would contribute significantly to this problem and might even be preferred to incandescent light sources. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#ae]*

f) Lupus erythematosus

Ultraviolet radiation aggravates this condition characterized by chronic inflammation of body tissues caused by autoimmune disease. Therefore, long-term exposure to CFLs could be a problem for patients. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#af]*

g) Skin cancers

Ultraviolet radiation is a major environmental risk factor for skin cancer, but the use of CFLs does not contribute significantly to the risk of developing it. Nevertheless, the design of CFLs has to respect the current restrictions for room lighting in terms of the amount of ultraviolet radiation that they emit, particularly in the UVC range. *More ... [see http://ec.europa.eu/health/opinions/en/energy-saving-lamps/l-3/5-skin-diseases.htm#ag]*

6. Do energy-saving lamps pose a risk to some groups of patients in the EU?

In contrast to incandescent lamps, fluorescent tubes emit some ultraviolet radiation. Energy-saving compact fluorescent lamps (CFLs) are similar in nearly all respects to fluorescent tubes which have been in widespread use in the Member States for many decades, but the types of ultraviolet radiation that they emit is slightly different. Besides ultraviolet radiation, the main causes for concern are flickering and the electromagnetic fields and blue light that these lamps produce.

Some people with epilepsy, as well as those who are very sensitive to light (photophobia) and those suffering from migraines, are adversely affected by **flickering lights**. The intensity of the light from energy-saving lamps varies constantly but at a rate that cannot normally be perceived as a flicker. Any residual flicker is unlikely to cause any harmful health effects even in susceptible individuals, unless the fluorescent tube is damaged.

Some people claim to be extremely sensitive to **electromagnetic fields** although they could not show this in controlled tests. To date there is no evidence that fluorescent lamps or CFLs contribute to such claimed hypersensitivity.

See also our publication on EMF [see http://ec.europa.eu/health/opinions2/en/electromagnetic-fields/index.htm]

Exposure to blue light and **ultraviolet radiation** has some health benefits: it boosts vitamin D levels and has beneficial psychological effects. However, ultraviolet radiation can also cause skin cancer so it is important to limit exposure, particularly to UVC. The main source of exposure to ultraviolet radiation is the sun, but people are also exposed to some ultraviolet radiation from fluorescent tubes and some types of spotlights predominantly used in offices and public spaces and increasingly in houses. The greatest change in lighting will occur in private homes as a result of the switch from conventional incandescent lamps to energy-saving lamps. This change may result in people being exposed to some ultraviolet radiation for longer periods and perhaps at higher intensities because energy-saving lamps are sometimes used closer to the skin than conventional fluorescent tubes, for instance in table lamps.

For the general population, the use of CFLs is unlikely to constitute a risk unless they use the lamps for long periods of time close to the skin, for instance a table lamp. In this case, the exposure to ultraviolet radiation could approach, but not exceed, acceptable limits. The use of energy saving CFLs with double glass envelopes or similar technology would remove this risk. Also, the high blue light content of some CFLs could damage the retina of people who place these lamps close to the eye.

People with disorders that make them exceptionally sensitive to ultraviolet or blue light radiation could be at risk from CFLs. Across Europe, approximately 250,000 people could be concerned, which represents 1 person out of 2000 (preliminary rough estimation of worst case scenario). However, these patients are constantly at risk of exposure to much higher levels of ultraviolet and blue light radiation from sources other than CFLs. Therefore, those patients are usually closely monitored and provided advice by health care professionals. The risk would be mitigated partly or entirely if the CFLs in the patients' homes were fitted with double glass envelopes or other methods decreasing ultraviolet and blue light radiation.

7. Conclusions

The widespread introduction of energy-efficient compact fluorescent lamps (CFLs) and the suggested phasing out of incandescent lamps has caused concerns among patients that CFLs could aggravate certain disease-related symptoms.

Based on the mode of operation of these lamps, the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) identified flicker, electromagnetic fields, and ultraviolet and blue light radiation as the three characteristics to be examined in order to assess the risks.

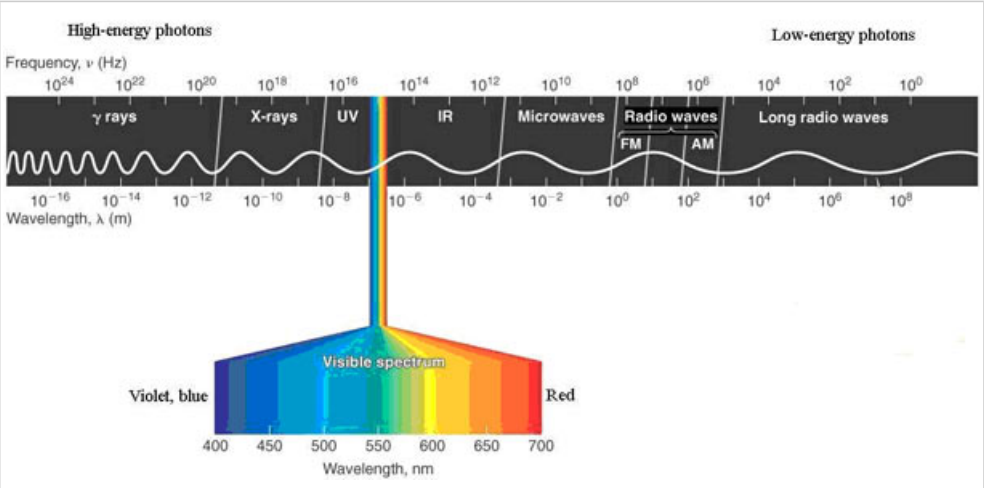
Based on this analysis, the Committee concluded that:

- There is no evidence to suggest that flicker from CFLs poses a risk to sensitive individuals.
- There is no evidence that electromagnetic fields generated by CFLs cause harmful effects.
- There is no evidence that the use of CFLs aggravates the symptoms of migraine, autism, Irlen-Meares syndrome, chronic fatigue syndrome, fibromyalgia, dyspraxia or HIV-infection and it is unlikely that fluorescent lamps can cause snow blindness or cataracts.
- The ultraviolet and blue light radiation from CFLs is a potential risk factor for the aggravation of symptoms in some light-sensitive patients with such diseases as chronic actinic dermatitis and solar urticaria. Across the EU, an estimated 250 000 patients could be concerned (preliminary rough estimation of worst case scenario).
- Using some single-envelope CFLs for prolonged periods of time near the body (at distances smaller than 20 cm) can result in ultraviolet exposures nearing current workplace limits set to protect workers from skin and retinal damage.
- The use of double-envelope energy-saving lamps or similar technology would largely or entirely mitigate risks both of approaching workplace limits on UV emissions in extreme conditions and the risk of aggravating the symptoms of light-sensitive people.

Annex

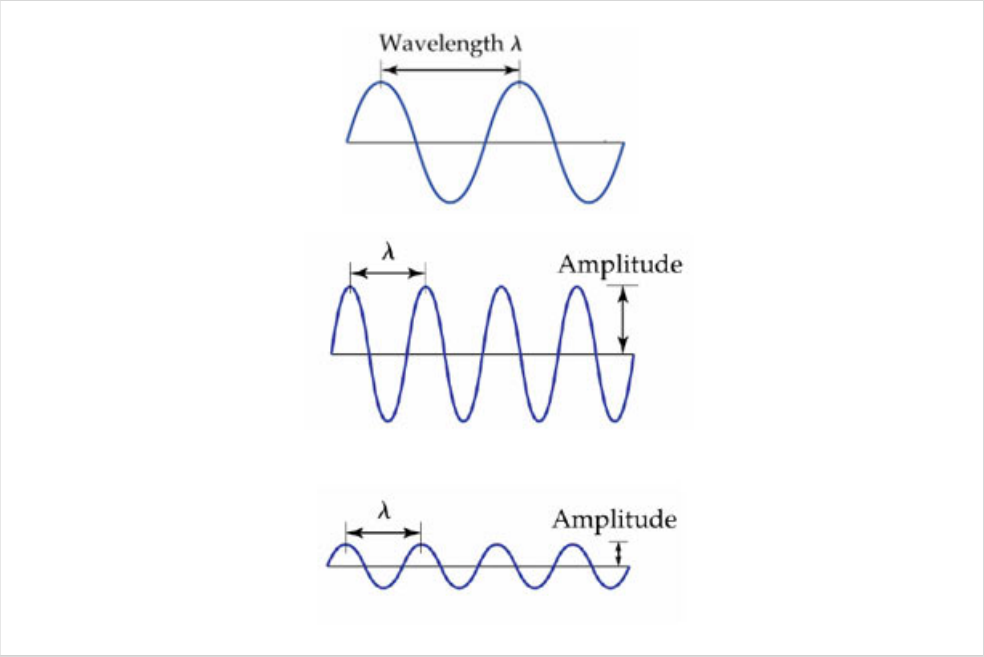
Annex 1:
The electromagnetic spectrum

showing the visible spectrum as well as ultraviolet (UV) and infrared (IR) radiation.



Source: Scientific Committee on Emerging and Newly Identified Health Risks, Light Sensitivity (2008) [see http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_019.pdf], 3. Scientific Rationale, p. 10

Annex 2:
Wavelength and amplitude



Electromagnetic waves are characterised by their wavelength (λ) which is the distance between successive peaks and is measured in units of length, and by their intensity, or amplitude, which is the height of each of those peaks.