TOPTEN ACT CRITERIA PAPER

Luminaires

31 August 2015

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Topten ACT aims at transforming the European market of energy-using products towards higher energy efficiency.
Topten ACT identifies the top energy-efficient products in 16 European countries, and makes this information available to consumers and large buyers on tailored national websites. The most energy efficient models in different product categories (such as household appliances, lighting, office equipment, consumer electronics, cars) are presented with comprehensive product information based on official labels and standardized declarations. Topten works with manufacturers and thus increases both market offer and consumer demand of high energy efficiency products. Topten is strictly neutral and independent from manufacturers and retailers, its selection criteria are always published online.
Topten ACT is supported by the European Commission's research and innovation programme Horizon 2020, and many national organisations (energy agencies, environmental and consumer organisations, research institutes). The Topten ACT project involves 17 partners in 16 European countries. It is coordinated by ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie).
More information and access to all national websites on the European site: www.topten.eu

WP2 European Product Analysis , Task 2.1 Determining energy efficiency criteria, D 2.1 Periodic Criteria Papers (first set)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°649647.

1. Topten.eu: luminaries - current selection criteria and products selected

A luminaire is a completer lighting unit consisting of one or more lamps with all of the necessary parts and wiring. For the purposes of this paper, they have been divided in domestic and office luminaires.

Domestic luminaires

There are currently no domestic luminaires on Topten.eu. Topten.ch however has an ongoing project with Swiss retailers and manufacturers to label the most efficient luminaires. To obtain the label, power, luminous flux and light spectrum of the luminaire must be measured and the following criteria must be met:

Luminous flux	>= 180 lumens (less bright luminaires are considered to have decorative function only)
Luminaire efficiency factor	>= 50 lumens per watt except when >90% indirect lighting >= 55 lumens per watt
Standby power	<= 0.5 W except when luminaires have an in-built dimmer <= 1.0 W
Colour rendering index (CRI)	>= 80 (only for luminaires using LED)
Colour temperature	<= 6500 kelvins (only for luminaires using LED)

Table 1: Topten.ch criteria for voluntary domestic luminaire label

Office luminaires

Topten.eu presents the most energy efficient luminaires for offices and other indoor use. The listed luminaires are certified by MINERGIE®, a Swiss label most famously known for building standards. Each brand is represented with their most energy efficient model per category. The complete list of Minergie-certified luminaires can be found under www.toplicht.ch (website available in German). Selection criteria can be found in detail but only in German under http://www.toplicht.ch/index.php?page=reglement, or summarised in English on the Topten.eu criteria page for office luminaires.

2. Expected selection criteria in 2016

No update planned for 2016

3. Technical background

Luminaire efficiency factor (lumens per watt)

Luminaire efficiency is expressed by the ratio of total luminous flux in lumens and total power in watts. This ratio is also called luminaire efficiency factor (LEF). It is equal to the product of the luminous efficacy of the light source, the light output ratio and the efficiency of the ballast.

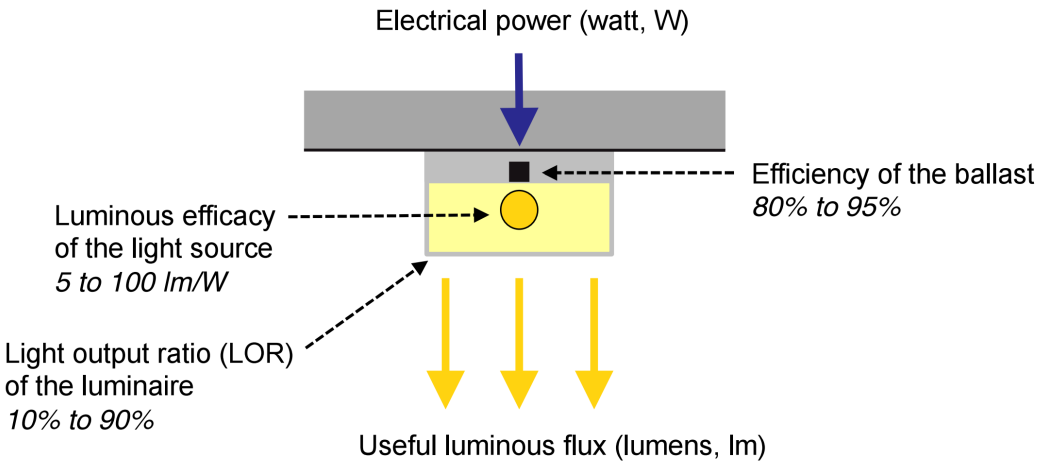


Figure 3: schematic of the luminaire efficiency factor (LEF)

Standby consumption

A 2014-2015 testing of some 200 domestic luminaires by Topten shows that around a third of them consume energy in off mode. Measured standby power tends to be around 0.5 watts, with some products consuming over 1 watt in off mode, and up to 3.6 watts. Standby energy use is very common among floor-standing, table and desk luminaires (74% of tested products). Wall or ceiling mounted luminaires rarely consume standby energy (6 of 116 tested products); when they do, it is typically because additional light switches, dimmers etc. are built into the luminaire.

In the EU, standby consumption is partially limited through requirements for control gear and ballasts (see page 6 below for more detail on these regulations). Other luminaire components can add to standby energy consumption. Typically they are components for lighting control like timer switches, occupancy sensors, light sensors and daylight regulation devices or illuminated switches. All these are not covered by EU requirements. In addition, dimmers are also exempt from the requirements.

Colour rendering

The colour rendering index (CRI) is a measure of how colours appear in artificial light compared to daylight. For luminaires, it depends on the CRI of the lamps themselves, but it is also affected by shades and diffusors in the lmuminaire, which can reduce colour rendering quality. The best value is 100 and is typically reached by halogen lamps. Values between 77 and 86 are accepted as good and typically reached by fluorescent and LED lamps. To enter the EU market LED lamps must have a CRI value of at least 80 (EU regulation No 1194/2012 0). LED lamps can reach excellent CRI values of nearly 100, however there is a trade-off with luminous efficiency. With the astonishing technological development of LED luminous efficiency in the last years (reaching over 100 and up to 140 lumens per watt), demand for LED lamps with excellent CRI could increase in the coming years.

The CRI value is an average calculated for 8 pastel colours. To only consider pastel colours is arguably not the best evaluation of colour rendering. There are 7 additional sample colours that would ideally be considered as well. They are saturated colours, leaf green and two skin colours. The saturated red, and to a lesser degree the saturated blue, rarely appear natural

in fluorescent or LED light. Figure 4 below shows all 15 sample colours and examples of typical CRI values for fluorescent and LED lamps.

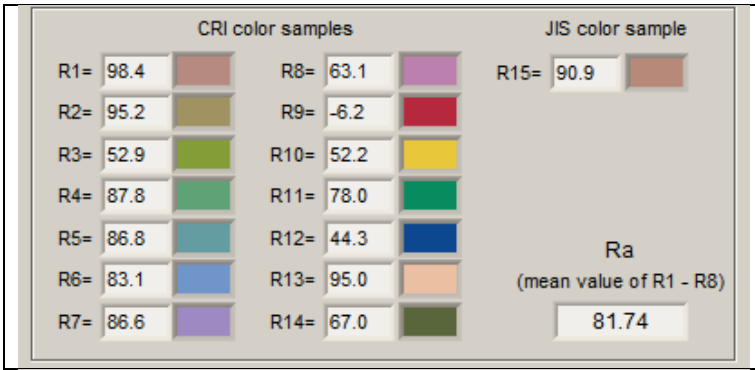
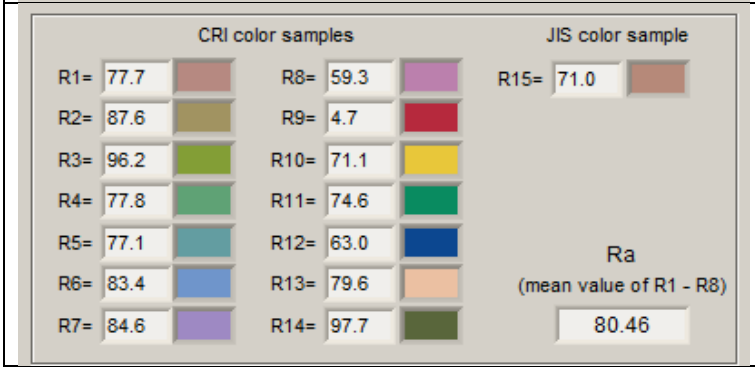
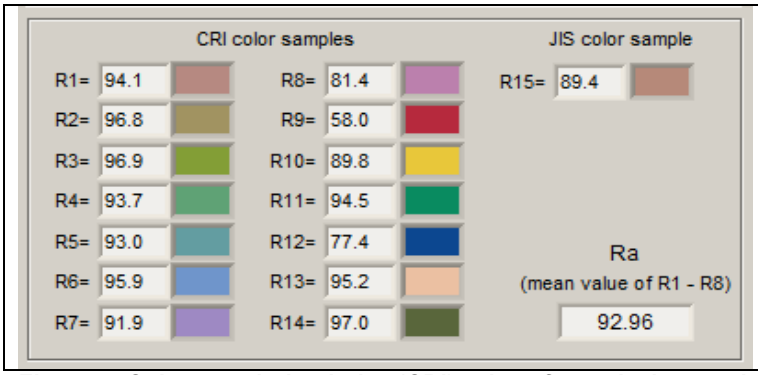
		Typical luminaire with fluorescent lamp
		Typical LED luminaire
		LED luminaire with excellent colour rendering

Figure 4: Colour rendering index (CRI) values for typical examples of different luminaires

4. Policy measures, standards and labels

EU Energy Label

There is no EU Energy Label for office luminaires. The EU energy label for household luminaires is covered by EU regulation No 874/2012. This label differs from all other mandatory EU energy labels since it does not refer to the product's energy consumption, light output or energy efficiency. Instead it indicates (in the official language of the country) only the energy efficiency class of light sources (lamps) included in the luminaire and available alternatives. There are numerous designs for the label reflecting the variety of light sources (see figure 5 below):

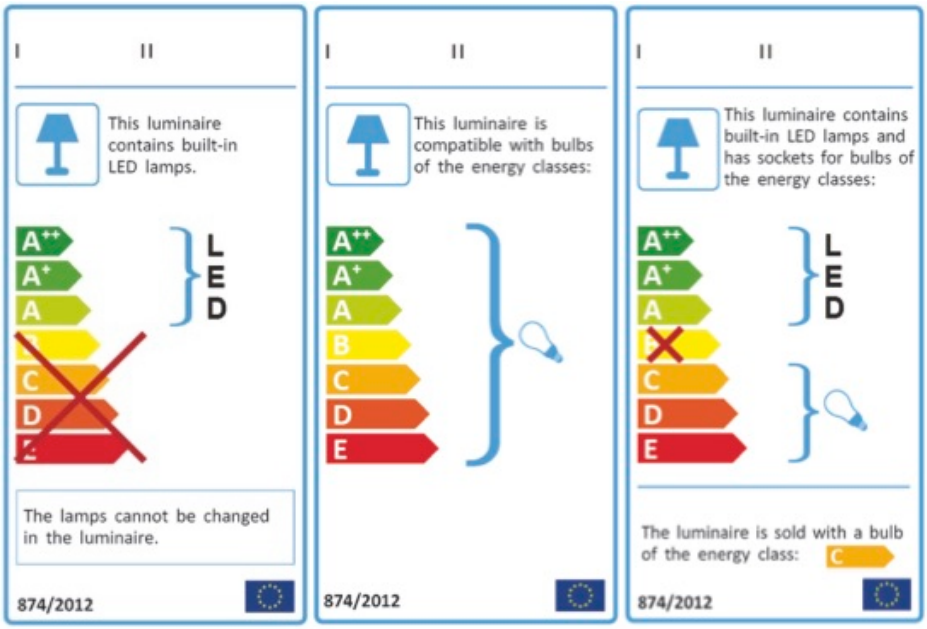


Figure 5: EU energy label for household luminaires (alternative layouts)

This label is not very useful in our opinion, as it does not show the differences in real energy efficiency and consumption of different luminaires. Tests carried by Topten show that there are large saving potentials in household luminaires: just within LED luminaires, the luminaire efficiency factor ranges from 10 - 100 lumens per watt. The EU energy label should make these differences visible to encourage more efficient luminaires.

Today the labelling regulation 1194/2012 (ecodesign of directional lamps and LED lamps) does not clearly formulate if product information has to be provided for the luminaire and/or the lamps. Most manufacturers declare for the lamps only, even if these are integrated and cannot be changed. It should be stated clearly that the product information should be declared for the luminaire, including standby power.

Topten recommends:

- To update the existing EU energy label for household luminaires with a real rating of luminaire efficiency (based on measured luminaire data and the calculation of an energy efficiency index as it is done for lamps).
- This would be a transitional step to bridge the time until the label is replaced with a good solution and to quickly improve product labelling and information at least for domestic luminaires with built-in LEDs: To include luminaires with built-in LEDs into the scope of EU regulations No 1194/2012 (ecodesign of directional lamps and LED lamps) and No 874/2012 (labelling of lamps and luminaires) at the next possible opportunity (e.g. the ongoing review of these regulations in 2015), so that luminaires are treated in the same way as LED lamps.
- Introduce a label for office luminaires, based on the same principles that have been described above for domestic luminaires. This was already recommended in the preparatory study Lot 8 for office lighting in 2007. This is important because office lighting is estimated to account for double the energy consumption of domestic lighting. A mandatory energy label for office luminaires would be a strong incentive for electricians, planners, private and public procurement agents and awarding authorities to consider more efficient products.

Ecodesign & Standby regulations

Existing Ecodesign regulations do not cover luminaires. They set performance requirements only for the lamps to be used in the luminaire. This is misleading because light is lost in diffusors and shades, and components for power conversion and lighting control use extra energy.

In the EU, standby consumption is partially limited through requirements for control gear and ballasts in regulations No 1194/2012 and No 245/2009. The limits are 0.5 watts for fluorescent lamps' ballasts (without integrated ballast) and 1.0 watt for other power converters like halogen convertors and transformers and LED drivers (0.5 watt as from 1 September 2016). Again, this is not enough for luminaires because many other components such as timer switches, occupancy sensors, light sensors and daylight regulation devices or illuminated switches also consume energy in standby.

Topten recommends that EU regulation No 1194/2012 (ecodesign of directional lamps and LED lamps) is revised to include minimum requirements for luminaire standby power for all luminaires (maximum 0.5 watts for luminaires in total, including integrated dimmers, touch-switches, sensors etc.).

5. Market analysis

No pan-European data exist on the luminaires market. In Switzerland, Topten tested some 200 luminaires throughout 2014-2015. This is part of an ongoing collaboration with Switzerland's two largest retailers, Coop and Migros, as well as other suppliers and manufacturers. Light output, power and colour spectrum were measured during the tests.

The results show that there are large saving potentials in household luminaires which are currently not communicated to consumers. Luminaire efficiency ranges from 10 - 100 lumens per watt; and standby energy consumption is common and sometimes unnecessarily high. Measured colour rendering values of LED luminaires were generally good though could improve.

We observe that the market share of luminaires with built-in LED lamps is growing. Since these lamps cannot be changed it is important that consumers have the best possible product information, as described in the policy section above. For these luminaires, test results show that, had the efficiency classes of luminaires been calculated in the same ways as it is done for LED lamps, then most of the luminaires would fall in class A. By contrast, the current domestic luminaires label seems to indicate that these luminaires can reach the A++ classes. A luminaire that really belongs to class A++ (measuring its luminous flux as it is done for LEDs) saves:

- over 80% compared to class B or C luminaires;
- over 50% compared to class A luminaires;
- over 25% compared to class A+ luminaires.

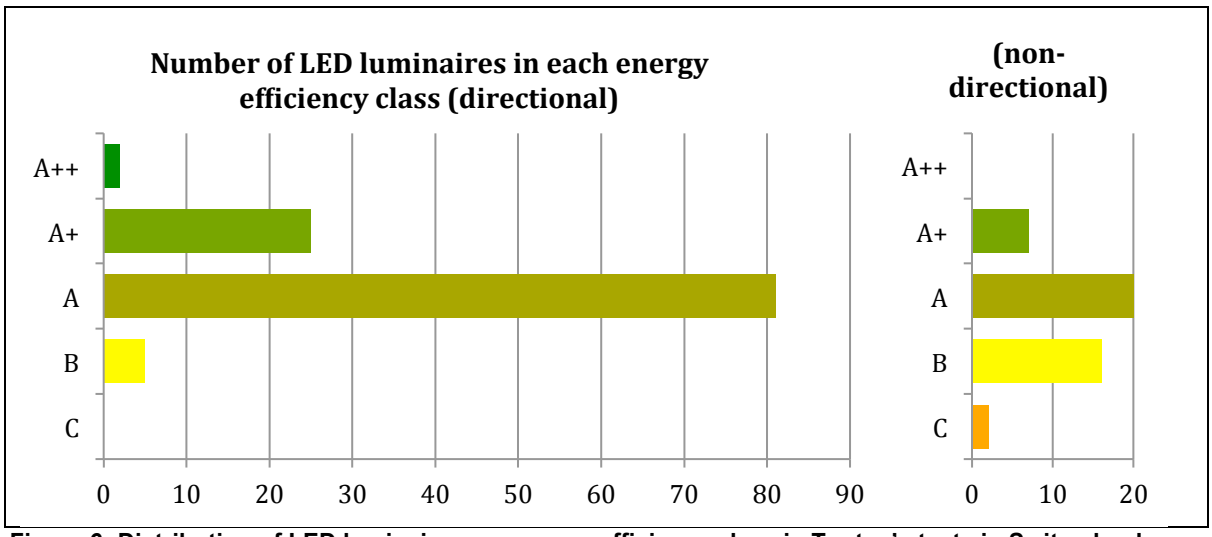


Figure 6: Distribution of LED luminaires per energy efficiency class in Topten's tests in Switzerland

6. References and links

Useful links

Topten Criteria for Household Luminaires:

German: http://www.topten.ch/?page=auswahlkriterien_wohnleuchten&fromid=
French: http://www.topten.ch/?page=Crit-f-luminaires-d-interieur&fromid=
Italian: http://www.topten.ch/?page=Crit-lampade-casa&fromid=

Topten.eu selection criteria for office luminaires:
http://www.topten.eu/english/criteria/office_lighting_crit.html&fromid=

Topten.eu lists of selected office luminaires:
http://www.topten.eu/english/lamps/office-luminaires/ceiling-mounted.html
http://www.topten.eu/english/lamps/office-luminaires/recessed.html
http://www.topten.eu/english/lamps/office-luminaires/suspended.html
http://www.topten.eu/english/lamps/office-luminaires/floor-standing.html
http://www.topten.eu/english/lamps/office-luminaires/desk.html
http://www.topten.eu/english/lamps/office-luminaires/wall-mounted.html
http://www.topten.eu/english/lamps/office-luminaires/spots.html
http://www.topten.eu/english/lamps/office-luminaires/downlights.html

S.A.L.T., Swiss Alpine Laboratories for Testing of Energy Efficiency, http://www.salt-chur.ch

References

Commission Delegated Regulation (EU) No 874/2012 of 12 July 2012 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of electrical lamps and luminaires.
http://www.topten.eu/uploads/File/Regulation-874-2012_label-lamps-luminaires.pdf

Amendment regarding Online Energy Labels: Regulation No. 518/2014

http://www.topten.eu/uploads/File/Online-Energy-Labels-518:2014-EN.pdf

Commission Regulation (EU) No 1194/2012 of 12 December 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for directional lamps, light emitting diode lamps and related equipment.
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R1194&from=EN

Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council
http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=URISERV:en0030&from=EN

'Luminaire efficiency: what mandatory and voluntary labels achieve, and what they should achieve in the future' Eva Geilinger et al., August 2015.

- *Full Paper:*
  http://www.topten.eu/uploads/File/EEDAL15_Eva_Geilinger_Luminaire_efficiency.pdf
- *Slides presented at EEDAL'15 conference:*
  http://www.topten.eu/uploads/File/EEDAL15_Eva_Geilinger_Presentation_Luminaire_efficiency.pdf