Lighting Res. Technol. 2020; **52**: 582

Opinion: Lessons learned from life cycle assessments

The Society of Light and Lighting

Life cycle assessment is a methodology used to assess potential environmental impacts over the entire life of a product from extraction of raw materials through manufacturing, transportation and use, to disposal at the end of life. It also helps to evaluate the relative effects of each phase of the life cycle on the impacts. These effects depend mainly on how the electricity consumed during use is generated. Currently, three main sources of electricity production can be distinguished: fossil fuels, nuclear and renewables.

For an average LED lamp available today (i.e. efficacy of 95 lm/W, lifetime of 25,000 hours and 11 W of power), we compare the potential impacts for three countries using different electricity mixes: Australia uses fossil fuels (85% of electricity production), Norway uses renewables (more than 95% of electricity production) and France uses nuclear (72% of electricity production). In Australia, 86% of potential impacts are generated by the use phase over 25,000 hours. In France, the contribution of the use phase decreases to 37%. In Norway, it represents only 29%. The lamp manufacturing phase, which includes raw materials extraction and manufacturing processes, is responsible for the remaining impacts (transport and end of life are less than 1%).

For Australia, when we improve lamp efficacy by 40% (i.e. from 95 to 133 lm/W, as expected in the next couple of years), while adjusting the lamp power, from 11 W to 8 W, to keep a similar luminous flux, we reduce the potential impacts by 26%. On the other hand, when lamp lifetime increases by 40%, from 25,000 to 35,000 hours, the potential impacts are reduced by only 4%. In France, we observe the opposite: improving the luminous efficacy in the same way, a 13% reduction in potential impacts is observed, while a longer lifetime will have a better effect with a reduction of 19%. In Norway, a longer lifetime shows almost double the reduction in potential impacts that a higher luminous efficacy does (respectively 21% and 11%).

These results confirm that the way of producing electricity influences the relative weights of the manufacturing and use phases. Improving luminous efficacy will reduce the impact of the use phase by decreasing energy consumption and will be most effective for an energy mix dominated by fossil fuels. For countries with a large proportion of renewables or nuclear in their electric mixes, increasing the lifetime or recycling/reuse is more efficient because it mitigates the impacts of the manufacturing phase which is found to be predominant under these conditions. Each country must be aware of these issues in order to propose appropriate products and adopt the best strategy to reduce the environmental impacts of lighting systems.

Kevin Bertin[a], Georges Zissis PhD[a] and Marc Mequignon PhD[b]
[a]*Laboratoire Plasma et Conversion d'Energie, Université de Toulouse, Toulouse, France*
[b]*Laboratoire d'Etudes et de Recherches Appliquées en Sciences Sociales, Université de Toulouse, Toulouse, France*

Address for correspondence: Georges Zissis, Laboratoire d'Etudes et de Recherches Appliquées en Sciences Sociales, Université de Toulouse, Toulouse, France.
E-mail: georges.zissis@laplace.univ-tlse.fr

10.1177/1477153520940904