European Commission

Science for Environment Policy

Comparing life-cycle costs of road-lighting technologies

The economic costs of replacing energy inefficient high-pressure mercury (HPM) lamps, used in outdoor lighting, with more efficient alternatives have been explored in a recent study. High-pressure sodium (HPS) lamps would be more cost effective than light-emitting-diode (LED) technology, although the researchers say LEDs could become more economical in the future.

Outdoor lighting, such as for streets, pedestrian walkways and car parks, consumes a considerable amount of energy. In Finland for example, outdoor lighting was responsible for around 1% of the country's electricity consumption in 2010.

Reducing energy use is essential for a sustainable future. In the EU, as part of the drive towards an energy-efficient society, inefficient HPM lamps, which have been used extensively for outdoor lighting, were banned in 2015. Consequently, cities and municipalities must replace around 18 million HPM lamps with more energy efficient technologies.

Two suitable replacements are HPS and LED technologies. HPS lamps, a light source used for a long time in many countries, are installed in a luminaire with a suitable ballast (generally the luminaire contains one HPS lamp and one ballast). In contrast, LED luminaires, developed more recently, may contain numerous LED modules (or a LED lamp) and a control gear. LED luminaires offer improved energy efficiency, superior lighting characteristics and greater flexibility in use, but cost more to purchase.

To help authorities assess the costs of replacing HPM lamps, this study used life-cycle costs analysis (LCCA) to compare HPS and LED technologies. LCCA considers the economic impacts of each technology over its lifespan and can be used to find the most cost-effective alternative. The analysis covered the present-value costs of purchasing, installing and disposing of the luminaires and the maintenance and energy used over 30 years (a recommended time frame for conducting LCCA of road lighting).

The researchers only considered replacing the lamps and their associated components and not the rest of the lighting infrastructure, such as the poles and wires. They estimated residual value to be 25% of the value of the original purchase price, that the luminaires would be used for 4 000 hours a year and that electricity would cost 0.1 euros per kilowatt hour (€/kWh) (a value used in planning for one Finnish city) over the 30 year period. The researchers used technical data from the manufacturers, and for LEDs, projected increases in luminous efficacy and a falling purchase price as the technology is further developed. The study was based on road lighting standards for motor vehicles on medium to high speed traffic roads in dry and wet conditions in Finland.

The analysis showed that it would be more economical to use HPS than LED luminaires. For each kilometre of lit road, the HPS total life-cycle costs were 45% less than for LEDs. The initial investment of an LED unit was approximately 2.3 times more than for an HPS luminaire, although energy costs over the 30-year period for LEDs were 27% less than for HPS luminaires. Maintenance costs for LEDs were 17 times more than for HPS and the residual value was 2.3 times more.

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Source: Tähkämö, L., Räsänen, R-S. & Halonen, L. (2015) Life cycle cost comparison of high-pressure sodium and light-emitting diode luminaires in street lighting. *International Journal of Life Cycle Assessment* 21(2): 137-145. DOI:10.1007/s11367-015-1000-x

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The researchers found that if the cost of electricity was doubled, HPS luminaires would still be a more economical choice than the energy efficient LEDs. Electricity would have to cost 0.52 €/kWh before LED replacements would be the most cost-effective option.

LEDs would only become the better option if: electricity prices increased; the purchase price of LED luminaires was significantly reduced; and the modularity of LED luminaires improved (reducing the maintenance cost).

Although this study suggests HPS technology would be the better replacement technology at present, the researchers say they expect technical development of LEDs to improve, such that LEDs last longer, cost less to run and maintain, offer more efficient lighting and cost less to buy than HPS lamps, making LEDs more economical in the future. Furthermore, the optics of LED enable long pole distances, thus reducing life cycle costs. It should also be noted that the research included a case study analysing only one luminaire of each technology, and results may vary by case.