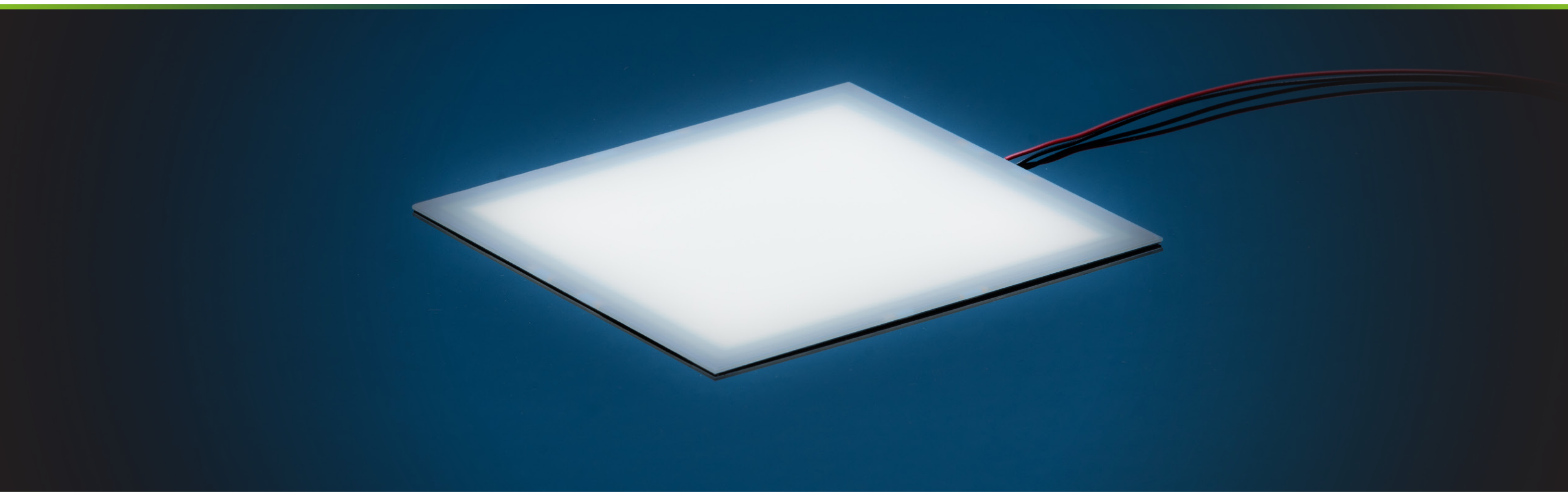
CASE STUDY

New York State
Pollution Prevention Institute

Life Cycle Energy and Environmental Impacts of an OLED



Challenge

OLEDWorks requested that the NYSP2I study and quantify the life cycle environmental impacts of their OLED lighting panel via life cycle assessment (LCA).

Solution

NYSP2I performed an ISO 14040/44 compliant LCA of OLEDWorks' non-flexible OLED general lighting panel, specifically the 3000K Brite 3 FL300 (square) panel used at full brightness (300 lumens) with a lifespan (L70) of 30,000 hours.

Results

- The energy to power the OLED during use dwarfs the impacts from the OLED itself, contributing 98% of the GWP and 78-99% to all other impacts.
- To reduce GWP impacts, increase the energy efficiency of the OLED itself. For every 1% increase in energy efficiency, life cycle GWP is reduced by about 1%.
- Excluding use energy, distribution is the most significant contributor to GWP, followed by OLED materials and the manufacturing and assembly processes.
- Landfilling the OLED at end of life is not a significant contributor to environmental impacts.

OLEDWorks

OLEDWorks manufactures organic light-emitting diode (OLED) lighting panels for use as light engines in lamps and other area lighting. Potential green building customers have requested global warming potential (GWP) and other environmental impact information for OLEDWorks' products.

Challenge

OLEDWorks requested that the NYSP2I study the life cycle environmental impacts of their OLED lighting panels via life cycle assessment. OLEDWorks was particularly interested in

Partnering with NYSP2I was an excellent way to quantify the environmental benefit of OLED solid state lighting panels. By analyzing the relative contribution of the processes, materials, and life cycle stages of the OLEDWorks Brite 3 OLED lighting panel to global warming potential (GWP) and environmental impact, we are able to show the panels' sustainability advantages, including that landfilling at end of life is not a significant contributor to environmental impacts. Uncovering the contribution of distribution and transport methods to GWP is an important finding, as it strengthens our commitment to building U.S.-based manufacturing capability and expanding our ability serve these markets in a more sustainable way.

Dr. Michael Boroson, CTO and Co-Founder, OLEDWorks

the impacts of materials, packaging, manufacturing, distribution, use energy, and landfill of the OLED lighting panels.

Solutions

The NYSP2I performed an ISO 14040/44 compliant LCA of OLEDWorks' rigid OLED general lighting panel, specifically the 3000K Brite 3 FL300 (square) panel used at full brightness (300 lumens) with a lifespan (L70) of 30,000 hours. While the baseline scenario excludes energy to illuminate the panel during use, use scenarios are included to account for illumination energy during operation. In the Use Scenario, the OLED is operated in a commercial environment for 12 hours per day for 6.85 years or in a residential environment for 4 hours per day for 20.5 years. In both scenarios, the OLED uses 128 kWh of 2019 US average grid energy. The OLED is manufactured in Aachen, Germany, and transported to a US customer where it is used and landfilled at end of life.

The goal of this LCA is to understand the relative contribution of processes, materials, and life cycle stages to GWP and the environmental impact of OLEDWorks' OLED general lighting panel.

Results

The OLED lighting panel life cycle analysis found that **energy to power the panel during use dwarfs the impacts from other areas of the life cycle, contributing 98% of the GWP and 78-99% to all other impacts**. This is consistent with other solid-state lighting technologies, such as inorganic LEDs[1]. While improvements to the OLED lighting panel have the potential for reducing environmental impact(s), the largest opportunity for improvement is increasing energy efficiency of the OLED. **For every 1% increase in energy efficiency, life cycle GWP is reduced by about 1%**.

Using an up-to-date grid mix representative of the geography where the OLED lighting panel is used is the most important factor when calculating the impact of the use scenario. Impact varies significantly, in some cases by more than a factor of four, with changes in the grid mix.

Excluding use energy, distribution is the most significant contributor to GWP, followed by OLED materials and the manufacturing and assembly processes. Eliminating the need to transport the finished OLED lighting panel or a significant mass of OLED materials via air presents the biggest opportunity to reduce the GWP of the panel. Establishment of more regional manufacturing locations could also further reduce the contribution of panel distribution to GWP.

Landfilling the OLED at end of life is not a significant contributor to environmental impacts, contributing 0.5% of the GWP and less than 5% to all other impacts, with most below 1%.

This analysis highlights the **need for OLED-specific life cycle inventory data**. OLEDs are a relatively new technology and very little life cycle inventory data is available. While the surrogate data used in this analysis is appropriate, the use of data sets specific to OLED materials, manufacturing, and assembly would further reduce uncertainty and increase the precision of the results.

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[1] Life-Cycle Assessment of Energy and Environmental Impacts of LED Lighting Products, Part 2: LED Manufacturing and Performance, US Department of Energy, May 2012, https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-21443.pdf

Partners

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