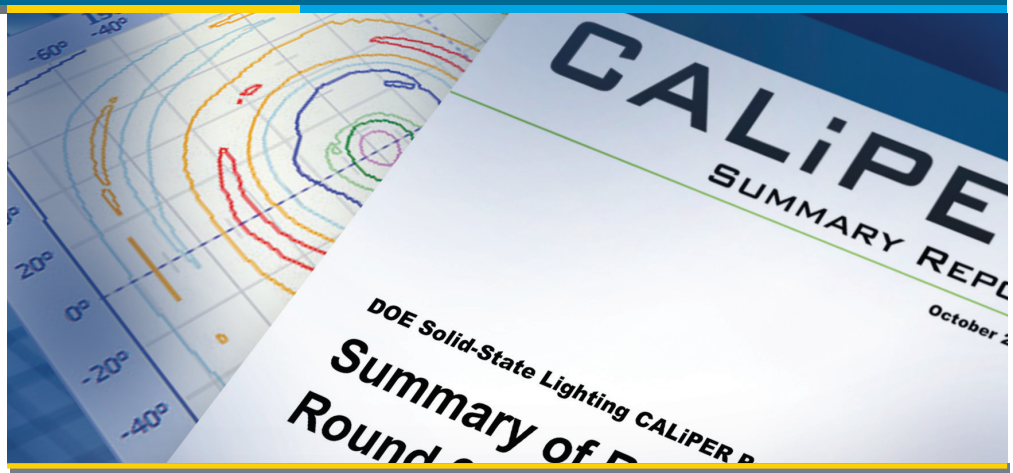
SOLID-STATE LIGHTING:

CALiPER Program Supports Unbiased Testing, Promotes Consumer Confidence

As solid-state lighting (SSL) technologies change and improve rapidly, products emerging on the market exhibit a wide range of performance. CALiPER meets the need for reliable, unbiased product performance information to foster the market for high-performance SSL products.



While CALiPER testing shows notable improvement in SSL technologies each year, performance of individual products varies widely. *Illustration courtesy of Akoya.*

In 2006, the U.S. Department of Energy (DOE) launched the Commercially Available LED Product Evaluation and Reporting (CALiPER) program to support testing of a representative array of SSL products for general illumination, using industry-approved test procedures. The CALiPER program serves multiple needs:

- Providing the public with independent, unbiased product performance information
- Guiding DOE planning for research and development (R&D), technology demonstration, and procurement
- Informing the development and refinement of standards and test procedures for SSL products.

Testing Procedures and Methods

Guidelines for selecting products for CALiPER testing ensure that the overall set of tests delivers insights across a range of lighting applications, product categories, and performance characteristics; a mix of manufacturers and devices; and variations in geometric configurations that may affect testing and performance. In addition, CALiPER testing measures variability across units and establishes benchmarking data with respect to other light source technologies and LED thermal management.

Products selected for testing are purchased anonymously and sent to qualified independent testing laboratories. All luminaires are tested with both spectroradiometry and goniophotometry, along with temperature measurements (taken at the hottest accessible spots on the luminaire) and off-state power consumption. Standardized procedures are used for the tests, including the LM-79 standard for electrical and photometric measurement of SSL products.

Manufacturers of tested products are given the opportunity to comment on test results prior to report completion. Testing results, summaries, and analysis are then distributed via the DOE SSL website.

Results

CALiPER testing to date has revealed a wide range of performance, from poor to excellent. Some SSL products tested deliver light output and efficacies that equal or exceed comparable incandescent and CFL products. Others perform

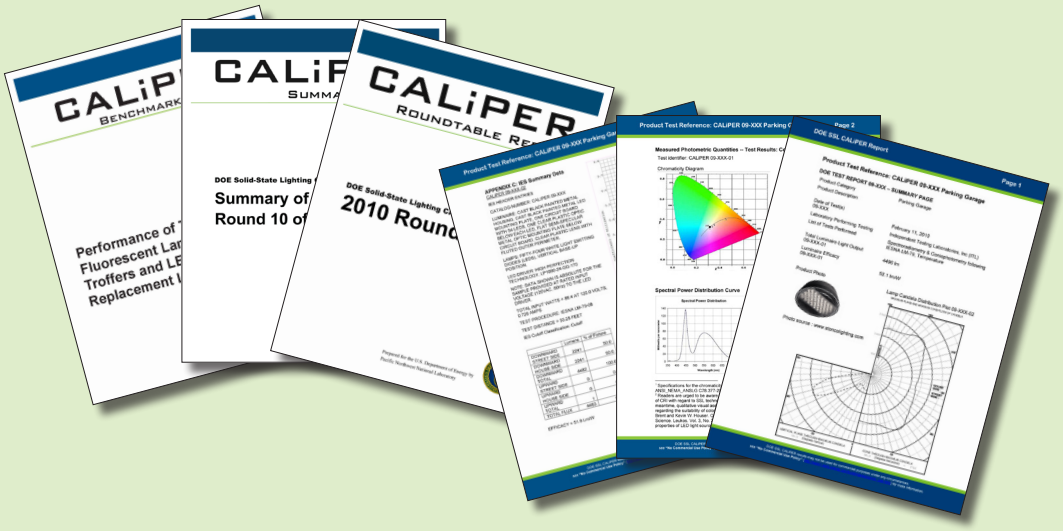
Performance Characteristics Studied Under CALiPER

Light Output and Distribution
Luminaire output (lumens)
Luminaire efficacy (lumens/watt)
Intensity distribution curves

Color Qualities
Spectral power distribution
Correlated color temperature
Color rendering index

Reliability
Thermal management
Lumen depreciation
In situ performance

Other Characteristics
Power factor
Off-state power use
Flicker
Dimming



- **Detailed Test Reports** for each individual product tested are distributed in the public interest for non-commercial, educational purposes only.
- **Summary Reports** provide detailed analysis of the test results for all products included in each round of testing.
- **Benchmark Reports** help users better compare LED products with conventional lighting technologies.
- **Exploratory Studies** provide more nuanced analysis of test results related to critical issues such as reliability, dimmability, and color shift.

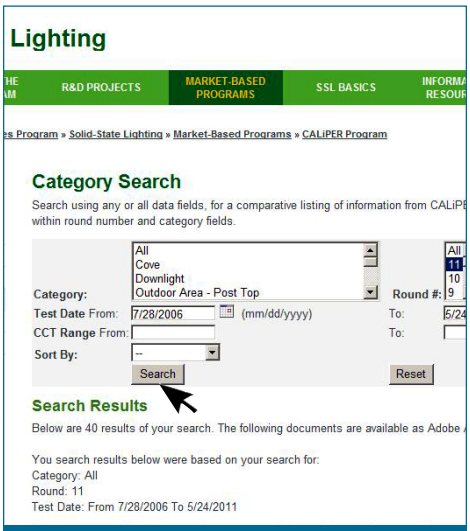
poorly and do not produce enough light output for their intended application to be considered a suitable replacement for any similar product in use today.

The great divergence in applications and performance characteristics highlights the need for buyers to consider the performance of each product separately and to require clear and accurate luminaire performance information from manufacturers. While some manufacturers are publishing credible values for luminaire output and efficacy, there is often wide disparity between performance claims in marketing literature and actual tested luminaire performance. The need for reliable standards, credible testing, and accurate information—both for manufacturers and the public—is clear.

Next Steps

Ongoing CALiPER testing shows notable improvement in each round of testing, underscoring the significant potential of SSL and the rapid pace of technology advances. As the technology and market evolve, the CALiPER program will evolve in response. Now that a number of SSL products are clearly competitive with compact fluorescent lighting (CFL) and incandescent products with respect to light output, color, and light distribution, CALiPER analysis also explores other, more nuanced characteristics such as glare, flicker, dimmability, and luminaire reliability.

Analysis of CALiPER test results and feedback from lighting manufacturers, efficiency programs, and utilities guide DOE planning for the CALiPER program as well as GATEWAY demonstrations and SSL R&D priorities. DOE hosts periodic CALiPER Roundtables to solicit input on test results, procedures, and additional testing needs for SSL. DOE has also established a guidance committee—including representatives from energy efficiency programs, utilities, the lighting design community, and key trade groups—to guide CALiPER program improvements and serve as a direct communications channel with stakeholders. To learn more about the CALiPER program and guidance committee, or to download the Roundtable reports, see ssl.energy.gov/about_caliper.html.



CALiPER test results are among the resources searchable on the DOE SSL website.

For More Information

For more information on CALiPER, see ssl.energy.gov/caliper.html or email calipersupport@pnnl.gov.

EERE Information Center

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