

Leveraging DOE SSL R&D

DOE SSL R&D Workshop
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Elements of the SSL R&D Program.....

..... You Can Be Involved

- Annual R&D Funding Opportunities
- Small Business Innovative Research (SBIR)
- OLED Testing Collaboration
- Intergovernmental R&D
- Facilitation of Working Groups

R&D Funding Opportunity Goals

- Maximize the energy-efficiency of SSL products in the marketplace
- Remove market barriers through improvements to lifetime, color quality, and lighting system performance
- Reduce costs of SSL sources and luminaires
- Improve product consistency while maintaining high quality products
- Encourage the growth, leadership, and sustainability of domestic U.S. manufacturing within the SSL industry

R&D Elements

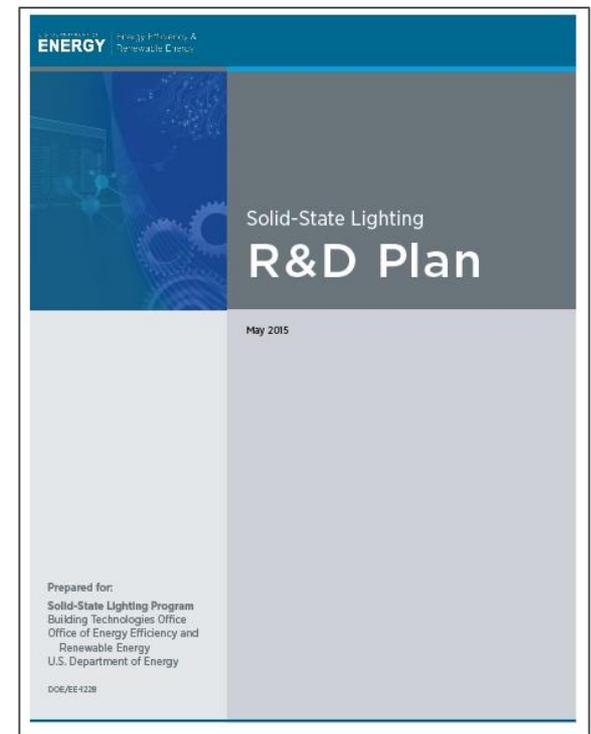
Core Technology Research: focusing on applied research for technology development, with particular emphasis on meeting efficiency, performance, and cost targets. This research fills technology gaps to overcome technical barriers

Product Development: using the knowledge gained from basic or applied research to develop or improve commercially viable materials, devices, or systems

Manufacturing R&D: aimed at accelerating SSL technology adoption and encouraging a role for U.S.-based production through manufacturing improvements that reduce costs and enhance product quality

Annual R&D Plan

- Former MultiYear Program Plan and Manufacturing Roadmap combined into a single document in 2015
- Updated annually in collaboration with industry partners
- Guides DOE SSL program priorities
- DOE SSL funding opportunity and project selections align with the priorities and targets detailed in the R&D Plan
- Informs not only DOE-sponsored R&D, but also research agendas in academia and industry



Current Funding Opportunity Status

| | |
|--------------------------------|-------------------|
| | |
| Funding opportunity released | October 29, 2015 |
| Concept papers due | November 20, 2015 |
| Full applications due | January 20, 2016 |
| Reply to reviewer comments due | March 14, 2016 |
| Selection announcement | June 2016 |
| Awards | September 2016 |

Historical View of All LED Projects

| Technology Gap | # Projects | Total Funding | Percentage of Funds |
|---|------------|----------------------|---------------------|
| A.1.1 - Alternative Substrates | 6 | \$6,358,989 | 3% |
| A.1.2 - Emitter Materials Research | 23 | \$36,181,801 | 17% |
| A.1.3 - Down Converters | 10 | \$15,494,999 | 7% |
| A.2.1 - Light Extraction Approaches | 3 | \$3,202,693 | 2% |
| A.2.2 - Novel Emitter Materials and Architectures | 6 | \$9,378,023 | 4% |
| A.4.4 - Manufacturing Simulation | 1 | \$425,000 | 0% |
| A.5.1 - Optical Component Materials | 1 | \$1,967,373 | 1% |
| A.6.3 - System Reliability Methods | 1 | \$3,561,176 | 2% |
| B.1.2 - Semiconductor Materials | 3 | \$10,155,219 | 5% |
| B.1.3 - Phosphors | 3 | \$8,567,818 | 4% |
| B.3.6 - Package Architecture | 12 | \$21,561,837 | 10% |
| B.5.3 - Diffusion and Beam Shaping | 1 | \$1,448,473 | 1% |
| B.6.1 - Luminaire Mechanical Design | 1 | \$1,091,907 | 1% |
| B.6.2 - Luminaire Thermal Management | 4 | \$8,564,141 | 4% |
| B.6.4 - Novel Luminaire Systems | 5 | \$6,520,058 | 3% |
| B.7.4 - Electronics Component Research | 2 | \$4,744,346 | 2% |
| C.1.1 - Novel Device Architectures | 1 | \$1,640,466 | 1% |
| M.L.1 - Luminaire Manufacturing | 4 | \$16,462,624 | 8% |
| M.L.3 - Test and Inspection Equipment | 2 | \$15,589,241 | 7% |
| M.L.4 - Tools for Epitaxial Growth | 4 | \$33,403,149 | 16% |
| M.L.5 - Wafer Processing Equipment | 1 | \$2,382,740 | 1% |
| M.L.6 - LED Packaging | 1 | \$1,097,648 | 1% |
| | 95 | \$209,799,721 | 100% |

Historical View of All OLED Projects

| Technology Gap | # Projects | Total Funding | Percentage of Funds |
|--|------------|----------------------|---------------------|
| C.1.1 - Novel Device Architectures | 6 | \$8,881,697 | 8% |
| C.1.2 - OLED Stable White Devices | 12 | \$17,458,641 | 16% |
| C.1.4 - Material Degradation | 1 | \$825,000 | 1% |
| C.2.2 - Electrode Research | 6 | \$6,620,080 | 6% |
| C.3.1 - Fabrication Technology Research | 1 | \$4,000,000 | 4% |
| C.6.3 - Novel Light Extraction Approaches | 4 | \$4,814,747 | 4% |
| D.1.1 - Implementation of Materials and Device Architectures | 7 | \$21,580,865 | 19% |
| D.2.1 - Substrate Materials | 2 | \$4,766,671 | 4% |
| D.2.2 - Low-Cost Electrode Structures | 1 | \$1,835,998 | 2% |
| D.4.2 - Luminaire Integration | 3 | \$5,486,404 | 5% |
| D.6.2 - Panel Packaging | 1 | \$4,955,031 | 4% |
| M.O.1 - OLED Deposition Equipment | 2 | \$3,293,293 | 3% |
| M.O.2 - Integrated Manufacturing and Quality Control | 3 | \$20,500,342 | 18% |
| M.O.3 - OLED Substrate and Encapsulation Manufacturing | 2 | \$7,151,946 | 6% |
| | 51 | \$112,170,715 | 100% |

Entire project portfolio: <http://energy.gov/eere/ssl/project-reports>

Small Business Opportunities (SBIR/STTR)

- Small business set aside for R&D
 - Small Business Innovation Research (SBIR)
 - Small Business Technology Transfer (STTR)
- Annual opportunities that typically include SSL topics
 - Phase I explores feasibility of innovative concepts with awards up to \$100,000 for about 9 months
 - Phase II focuses on the principal R&D effort, with awards up to \$750,000, over a two-year period
 - Only Phase I award winners may compete for Phase II funding



Small Business Opportunities

- Requires a Letter of Intent (LOI) prior to full application
- Recommended that you contact the technology manager listed in the funding opportunity to discuss your proposal idea prior to writing your LOI
- Performer retains rights to any technology developed and are encouraged to commercialize the technology

<http://science.energy.gov/sbir/funding-opportunities/>

Collaborative R&D OLED Testing Opportunity

Purpose

- Develop a collaborative R&D framework to accelerate developments in OLED lighting technology and manufacturing

Benefits

- Quicker turnaround for funding vs. solicitations
- Less daunting application
- Rapid results
- Collaboration with panel manufacturers
- Costs DOE less

OLED Testing Status Update

- DOE has qualified one testing laboratory to date and seeks additional qualified testing laboratories
- Have completed evaluation of 3 components
- Currently have 3 component tests ongoing
- DOE is currently reviewing multiple component applications/inquiries

Technology Validation Status Report

- Following completion of component testing, the testing laboratory will complete a Technology Validation Status Report (intended for a “non-technical audience”)
 - Summarizes the product tested and the test results
 - Provides any recommended actions and/or improvements in the design, operation, or future testing of the OLED component
 - Does not identify the manufacturer/product developer
- Appendix A is a comprehensive technical report that contains the following sections: Executive Summary, Background, Testing Process, Testing Results and Observations, Recommendations for Improvements/Best Practices, and Conclusions
- The report is generally not available to the public



Sample OLED Testing Feedback

"Thanks for the report, it is very useful and we appreciate the information you have provided...we are carrying out a full analysis of the samples provided to understand this a little better. Thanks again and thanks to the DOE for helping to have this work carried out." - Manufacturer for Component of Test 2

"Thank you for the clarification and providing the detailed data. These are very helpful for us to design and improve the next batch of samples." - Manufacturer for Component of Test 3

"It is always valuable to test new OLED materials. There is still a lot of room for improvement. The next breakthrough is just as likely to come from a small start-up or academic as from an established OLED materials company, because we are still early in our understanding of all of the important material parameters." – Component Testing Organization

<http://energy.gov/eere/ssl/oled-testing-opportunity>

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Intergovernmental Efforts

- Clean Energy Manufacturing Analysis Center (CEMAC)
 - Manufacturing costs and value-add along the supply chain
 - U.S.-specific competitive advantages
 - Potential market impacts of the manufacture of the components in commercial LED applications
- National Institute of Standards and Technology (NIST)
 - Supports lighting science and standards development
 - Color quality of LED and SSL sources



OLED Stakeholder Meeting

- Annual meeting established in 2013
- Creates an opportunity for open discussion concerning the development of OLED lighting
- Addresses 2 distinct objectives
 - Identify critical R&D needs
 - Identify market development challenges
- OLED Coalition formed as a result of initial meeting in 2013

LED Systems Reliability Consortium

- Collaborative ongoing effort to develop an advanced luminaire reliability model for SSL manufacturers and end users
- Increase consumer confidence and in turn accelerate adoption of LED technology
- Supported by competitive R&D project with RTI International
- Multiple publications
 - LED Luminaire Lifetime: Recommendations For Testing and Reporting (3 editions)
 - Hammer Testing Findings for Solid-State Lighting Luminaires
 - More on the way.....

2015 Connected Lighting Systems Meeting

- Meeting purpose: share perspectives and lay the groundwork for government/industry collaboration on the convergence of intelligent controllable light sources, communication networks, sensors, and data exchange in future lighting systems
- First meeting held November 16, 2015
- Follow-on meeting expected in June (details to come)

In the Future?

- Horticulture Lighting
- Animal Response to Light
- Roadway Safety
- Human Physiological Responses
- ???????

Learn More About Current Projects



Collaboration & Coordination Create a Bridge



SSL Program R&D



Advanced Research Projects
Agency-Energy (ARPA-E)



Small Business Innovation
Research (SBIR) Program



**NEW THIS YEAR:
Student Poster Winners**



National Science
Foundation SBIR
Program