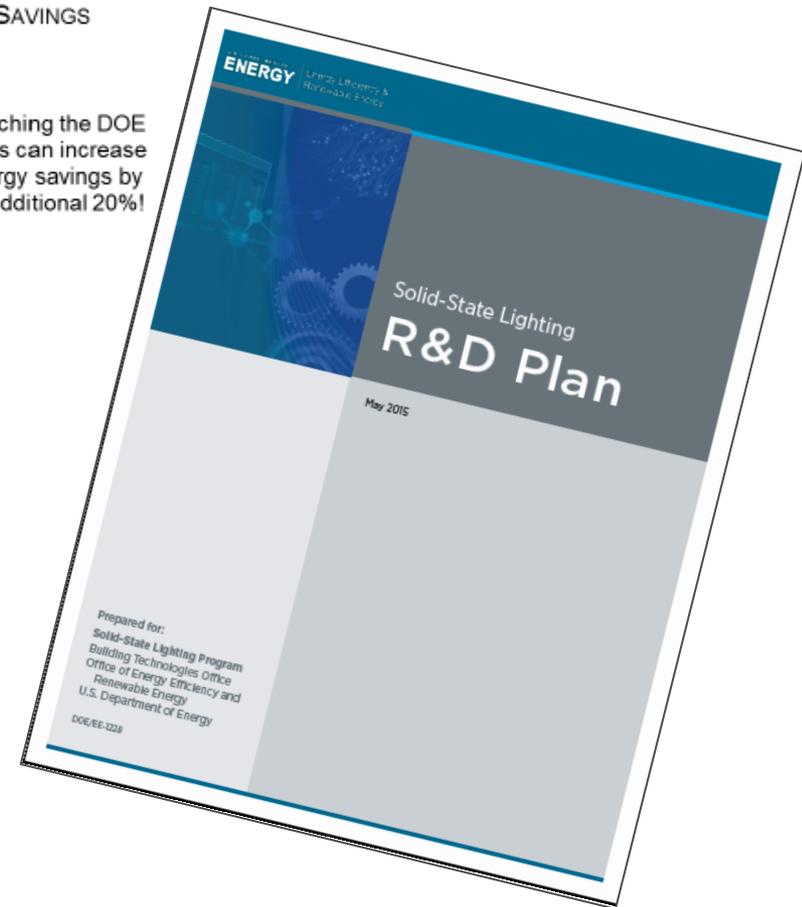
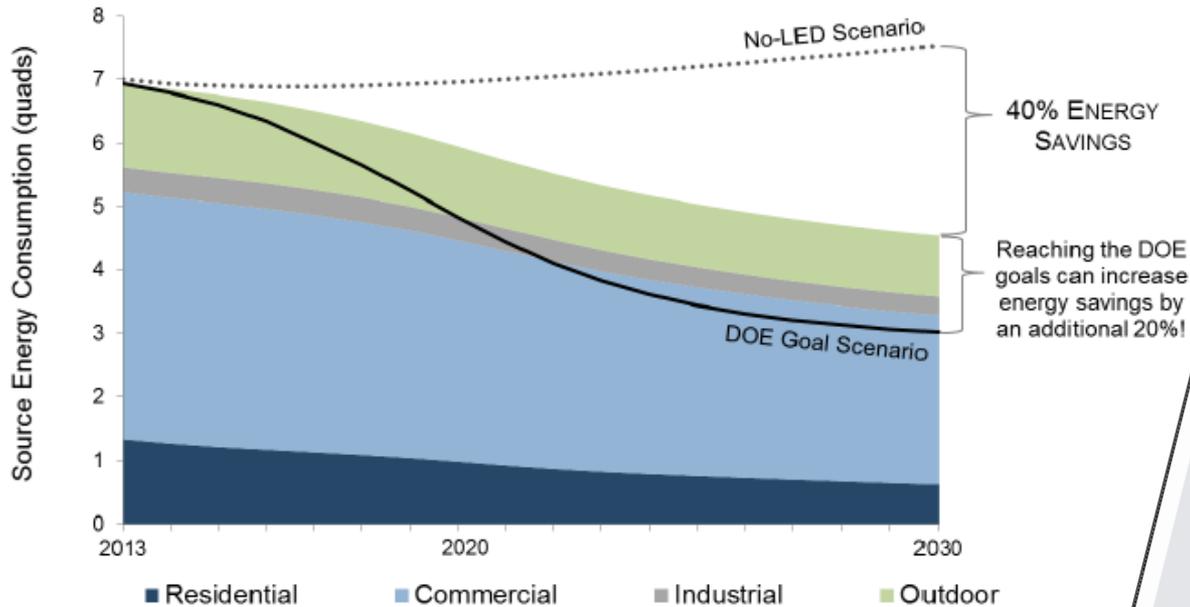


DOE SSL R&D Workshop Mission

DOE SSL R&D Workshop
Raleigh, NC
Feb 2-4, 2016

Morgan Pattison
DOE SSL Technical Advisor

Where are we going and how do we get there?



Where are we going?

Program Milestones

Year	Milestones
FY10	Package: >140 lm/W (cool-white); >90 lm/W (warm-white); <\$13/klm (cool-white)
FY12	Luminaire: 100 lm/W; ~1,000 lumens; 3500K; 80 CRI; 50,000 hours
FY15	Package: ~\$2/klm (cool-white); ~\$2.2/klm (warm-white)
FY17	Luminaire: >3,500 lumens (neutral-white); <\$100; >150 lm/W
FY20	Luminaire: 200 lm/W Smart troffer with integrated controls: <\$85

Note: Packaged devices measured at 25°C and 35 A/cm².

OLED Panel & Luminaire Milestones

Listed below are the current program milestones for OLED SSL. The industry is largely on track with targets to date, but recommended changes to existing metrics will be discussed and new metrics considered.

Year	Milestones
FY10	Panel > 60 lm/W
FY12	Laboratory Panel 200 lm/panel; > 70 lm/W; >10,000 hours
FY15	Commercial Panel <\$200/klm (price); >80 lm/W; 40,000 hours; CRI > 90
FY17	Commercial Panel: \$100/klm Luminaire: 100 lm/W; CRI > 90
FY20	High Performance Panel: 150 lm/W
FY25	Commercial Panel: <\$15/klm Luminaire: 150 lm/W; engineered light distribution

R&D Goals

Goals from 2015 R&D Plan

		2014 (Actual)		FY15		FY17		FY20		FY25		Overall Program Goal	
L E D	Warm-White Package**	146 lm/W [2015 R&D Plan Table 5.6]	\$1.7/klm [source: 2015 R&D Plan Table 5.8]	162 lm/W [2015 R&D Plan Table 5.6]	\$1.2/klm or ~\$1.1/klm [source: 2015 R&D Plan Table 5.8 and Table 7.3 resp.]	190 lm/W [source: 2015 R&D Plan Table 5.8]	\$0.7/klm [source: 2015 R&D Plan Table 5.8]	220 lm/W [2015 R&D Plan Table 5.6]	\$0.36/klm [source: 2015 R&D Plan Table 5.8]			250 lm/W [2015 R&D Plan Table 5.6]	\$0.3/klm [source: 2015 R&D Plan Table 5.8]
				50K [2015 R&D Plan Section 7.2.2]									
	Cool-White Package**	173 lm/W [2015 R&D Plan Table 5.6]	\$1.4/klm [source: 2015 R&D Plan Table 5.8]	185 lm/W [2015 R&D Plan Table 5.6]	\$1/klm [source: 2015 R&D Plan Table 7.3 and Table 5.8]	205 lm/W [source: 2015 R&D Plan Table 5.8]	\$0.6/klm [source: 2015 R&D Plan Table 5.8]	226 lm/W [source: 2015 R&D Plan Table 5.8]	\$0.35/klm [source: 2015 R&D Plan Table 5.8]			250 lm/W [2015 R&D Plan Table 5.6]	\$0.3/klm [source: 2015 R&D Plan Table 5.8]
				50K [2015 R&D Plan Section 7.2.2]									
	Luminaire	120, 110, or 108 lm/W [2015 R&D Plan Section 7.2.2], [2015 R&D Plan Task B.3.6] [R&D Plan Table 5.6] resp.		125 lm/W [2015 R&D Plan Table 5.6]		>150 lm/W [Source R&D Plan 2015 Table 7.3]	<\$100 [Source R&D Plan 2015 Table 7.3]	200 or 196 lm/W [Source R&D Plan 2015 Table 7.3 and Task B.3.6], [2015 R&D Plan 2015 Table 5.6] resp.				230 lm/W [2015 R&D Plan Table 5.6]	
	Omnidirectional Lamp*	78 lm/W [R&D Plan Table 2.1]	\$11/klm [R&D Plan Table 2.1]		\$10/klm [R&D Plan Figure 5.18]		\$6.9/klm [R&D Plan Figure 5.18]		\$5/klm [R&D Plan Figure 5.18]				
		25K [R&D Plan Table 2.1]											
	Downlight	60 lm/W [R&D Plan Table 2.1]	\$30/klm or \$20 [2015 R&D Plan Table 2.1 and Task B.6.4 resp.]						\$5 [2015 R&D Plan Task B.6.4]				
		36K [R&D Plan Table 2.1]											
Linear Troffer*	93 lm/W [R&D Plan Table 2.1]	\$31/klm [R&D Plan Table 2.1]						Smart Troffer with integrated controls <\$85 [source: R&D Plan Table 7.3]					
	56K [R&D Plan Table 2.1]												
Low/High Bay*	90 lm/W [R&D Plan Table 2.1]	\$38/klm [R&D Plan Table 2.1]											
	75K [R&D Plan Table 2.1]												
Streetlight*	93 lm/W [R&D Plan Table 2.1]	\$50/klm or \$200 [2015 R&D Plan Table 2.1 and Task B.6.4 resp.]						\$40 [2015 R&D Plan Task B.6.4]					
	55K [R&D Plan Table 2.1]												
O L E D	Panel	60 lm/W [R&D Plan Figure 6.4 and text above]		>80 lm/W (Commercial Panel) [2015 R&D Plan Table 7.4]	<\$200/klm (price for Commercial Panel) [2015 R&D Plan Table 7.4]		\$100/klm (Commercial Panel) [2015 R&D Plan Table 7.4]	150 lm/W (High Performance Panel) [2015 R&D Plan Table 7.4]	<\$100/klm [2015 R&D Plan Task M.0.5]		<\$15/klm (Commercial Panel) [2015 R&D Plan Table 7.4]	190 lm/W [R&D Plan Figure 6.4 and text above]	
		40K [2015 R&D Plan Task C.1.2]		40K hrs (Commercial Panel) [2015 R&D Plan Table 7.4]				>50K [2015 R&D Plan Task C.1.2]					
	Luminaire (normalized by panel #7)	46 or 51 lm/W [2015 R&D Plan Table 2.1 or Task D.4.2 resp.]	\$870/klm [R&D Plan Table 2.1]				100 lm/W [2015 R&D Plan Table 7.4]		125 lm/W [2015 R&D Plan Table D.4.2]		150 lm/W [2015 R&D Plan Table 7.4]		
	40k OR 15K [2015 R&D Plan Table 2.1 AND Task D.4.2 resp.]							50K [2015 R&D Plan Task D.4.2]					

Individual Feedback

2016 R&D WORKSHOP COMMENT CARD

Check the appropriate box to indicate what your comment relates to. One comment per card, please!

- A specific topic/task (which?) _____
- One of the “Questions to Consider” Topic Area: _____ Question #: _____
- What you’d like to see in the new R&D Program Plan
- Program Milestones Other *Name (optional):* _____

Remarks:

Please return completed cards to the Registration Desk at any time during the workshop.
(Extra cards also available there.)

LED - Group Discussion and Feedback

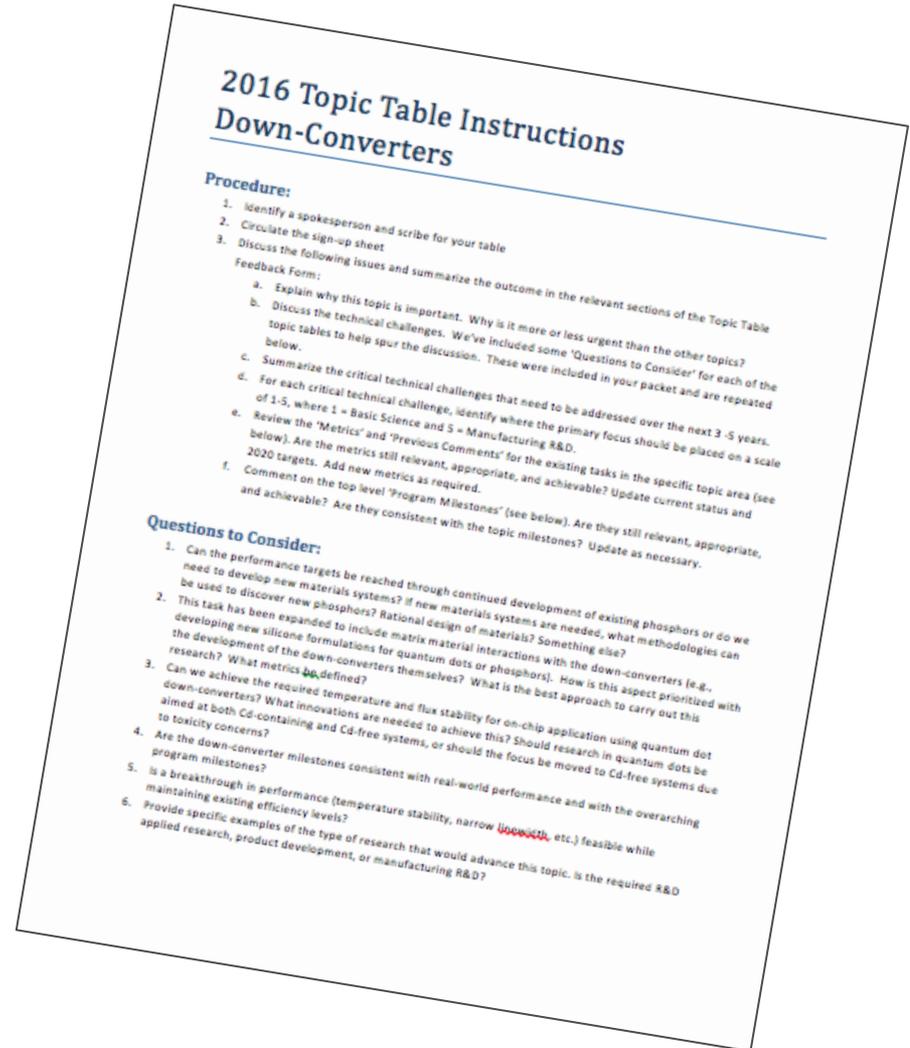


Topic Tables to discuss R&D priorities

1. Why is this topic important?
2. What are the technical challenges?
3. Are the metrics appropriate and accurate?
4. Do the R&D topic goals align with the over-arching program goals?

LED – R&D Topics

1. Emitter Materials
2. Down-Converters
3. Novel Devices
4. LED Packaging
5. LED Drivers
6. Reliability
7. Human Factors
8. Connected Lighting Systems
9. What else ...?



OLED – Group Feedback

OLED R&D Priorities from OLED Community Meeting

- C.1.2 Stable White Devices
- C.6.3 Novel Light Extraction & Utilization
- D.4.2 OLED Luminaire
- M.O.2 Manufacturing Processes
- M.O.6 Roll-to-roll OLED Manufacturing

Time for discussion in OLED Track Panels and a dedicated session for R&D Priorities and milestones discussion – Feb. 4, 1pm



OLED/LED – R&D Topic Output Example

C.1.2 Stable White Devices

Description: Develop novel materials and structures that can help create a highly efficient, stable white device. The device should have good color, long lifetime, and high efficiency, even at high brightness. The approach may include the development of highly efficient blue emitter materials and hosts or may comprise a device architecture leading to longer lifetime. Any proposed solutions should keep cost, complexity, and feasibility of scale-up in mind. Materials/structures should be demonstrated in OLED devices that are characterized to ascertain the performance as compared to the metrics below. Novel materials/structures should demonstrate high stability, while maintaining or improving other metrics.

Metrics	2014 Status	2020 Target
Lumen maintenance (L_{70}) from 10,000 lm/m ²	40,000	>50,000 hrs
Efficacy without extraction enhancement (lm/W)	35 lm/W	50 lm/W
CRI	90	>90

A.1.3 Down-Converters

Description: Explore new, high-efficiency wavelength conversion materials for the purposes of creating warm-white LEDs, with a particular emphasis on improving spectral efficiency with high color quality and improved thermal stability and longevity. Non-rare earth metal and nontoxic down-converters are encouraged.

Metrics	2014 Status	2020 Targets
Quantum yield (25°C) across the visible spectrum	95% (Green) 90% (Red)	99% (Green) 95% (Red)
Thermal stability – Relative quantum yield at 150°C vs. 25°C	90%	95%
Spectral FWHM	100 nm (Red/Green)	30 nm (Red) 70 nm (Green)
Color shift over time (when integrated into pc-LED)	$\Delta u'v' < 0.007$ at 6,000 hours	$\Delta u'v' < 0.002$ over life
Flux density saturation – Relative quantum yield (QY) at 1 W/mm ² (optical flux) vs. peak QY	-	95%

DOE SSL R&D Workshop – Inputs/Outcomes

Inputs-

- Presentations/Posters
- Comment Cards
- Group Discussion and Feedback
- Comments/Questions/Discussions

Outcomes-

- Updated Status/Goals/Objectives
- DOE SSL R&D Plan update
- R&D Priority Topics for funding
- Group Discussion and Feedback
- Other R&D

