

# BRINGING OLED LIGHTING TO MARKET

February 2, 2016

David DeJoy, CEO

2016 DOE Solid-State Lighting R&D Workshop



[OLEDWorks.com](http://OLEDWorks.com)

# OLEDWorks LLC

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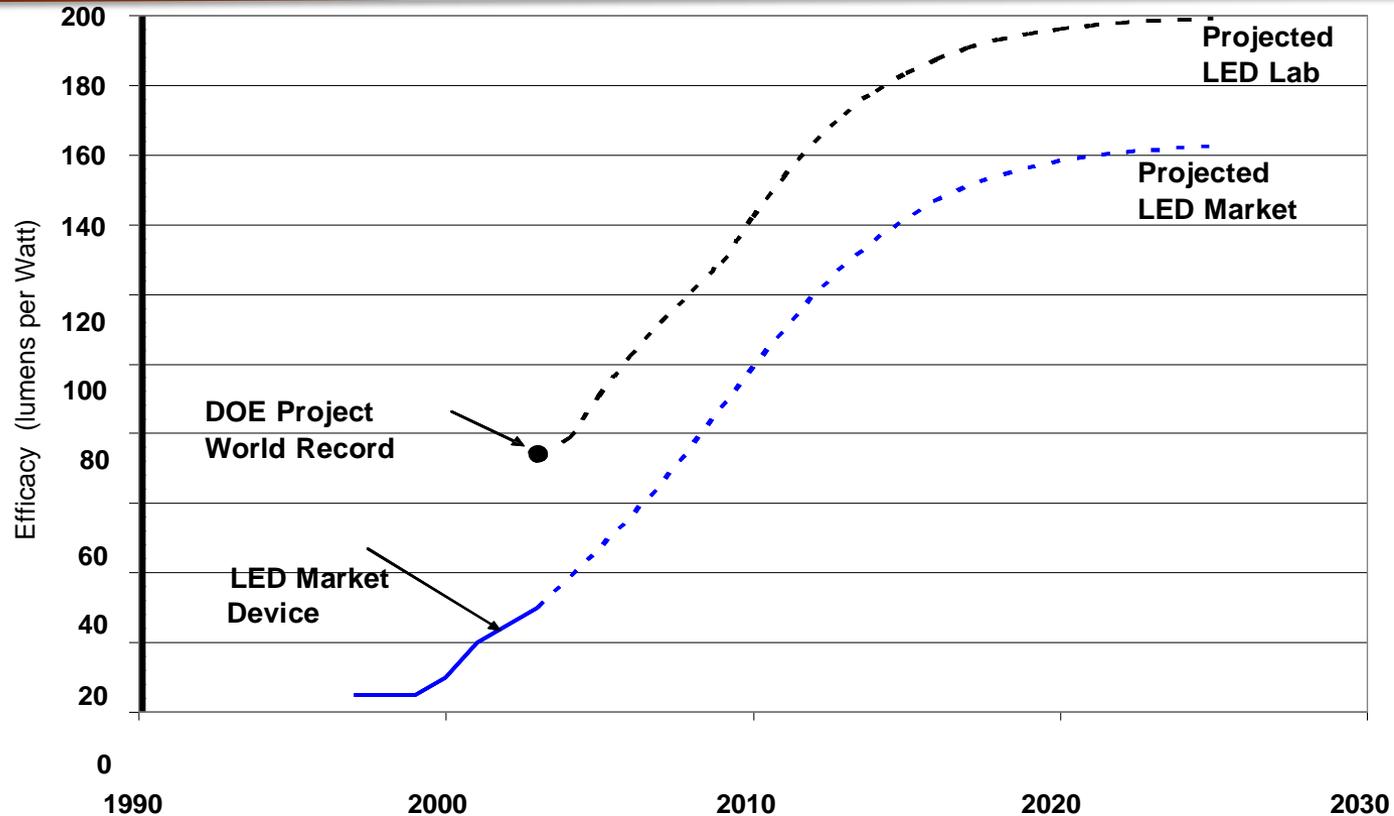
- About our company
  - OLED lighting manufacturer based in Rochester, NY
  - Founded in 2010 by Kodak OLED experts; staff grown from 8 to 25
  - Acquired Philips OLED lighting business October 30, 2015
- What we do
  - Manufacturing & R&D for OLED lighting Panels
  - DOE OLED test site for industry evaluations
- Target markets
  - Architectural, Commercial, Healthcare lighting
  - Residential, consumer lighting
  - Adjacent markets: transportation, appliances, etc.

# Time Travel to 2005 – Why I Love LED

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- Current acceptable energy efficiency but outstanding potential for improvements
- Solid-state device allows for controls
- Cost beginning to come down but potential for much lower cost at scale
- Excellent option for point light source but creativity will allow for many uses
- No mercury
- Resolve must be high for success to occur
- "Old technology" is really the biggest competition

# Time Travel to 2005 – Why I Love LED



**Figure 3-1: White Light Efficacy Targets, Laboratory and Market**

Source: 2005 SSL Program Planning Workshop

# Jump Ahead to 2016 – Why I Love OLED

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- Current acceptable energy efficiency but outstanding potential for improvements
- Solid-state device allows for controls
- Cost beginning to come down but potential for much lower cost at scale
- Excellent option for *area light source* but creativity will allow for many uses
- *Beautiful, broad spectrum light source*
- No mercury
- Resolve must be high for success to occur
- *Complementary technology to LED, but the bar is higher!*

# Jump Ahead to 2016 – Why I Love OLED

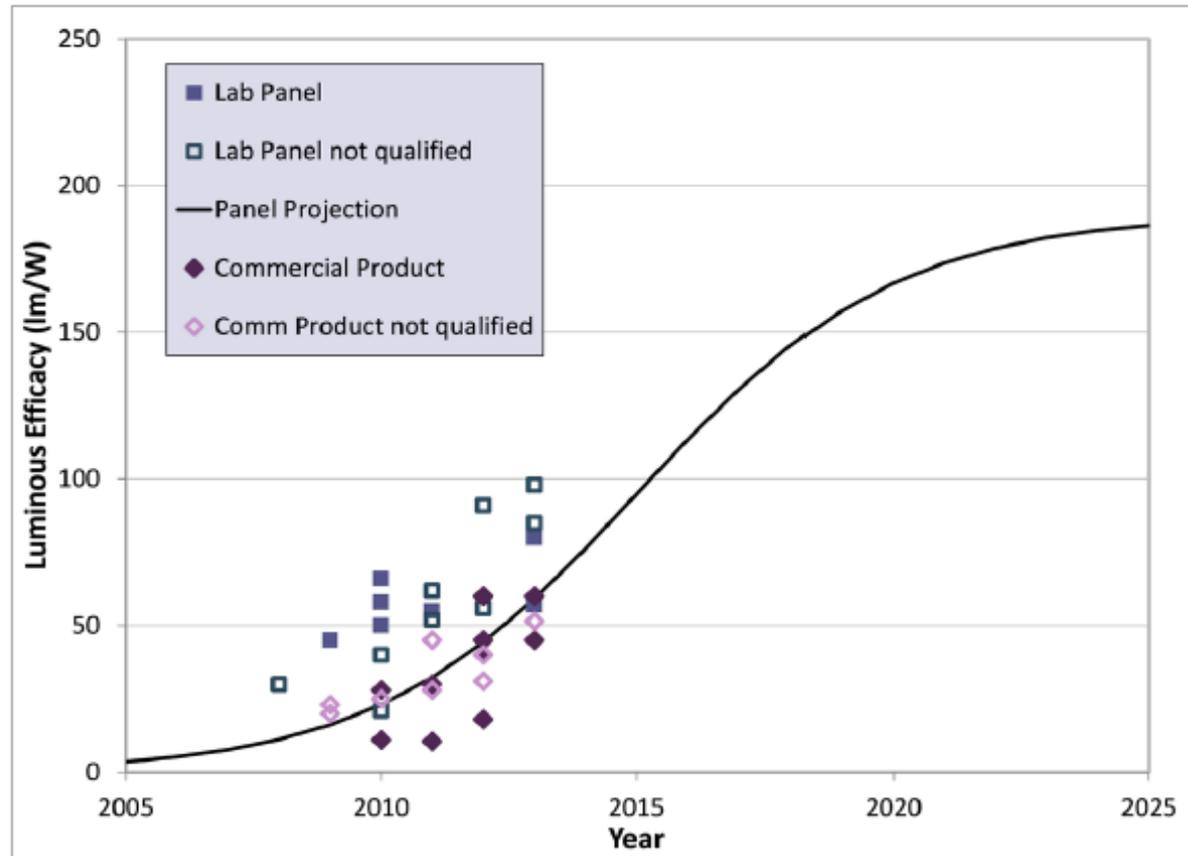


Fig. 4.2, 2014 SSL Multi-Year Program Plan: [www.ssl.energy.gov/techroadmaps.html](http://www.ssl.energy.gov/techroadmaps.html)

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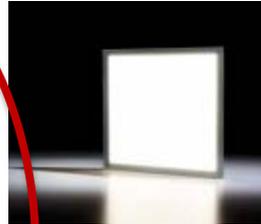
# Global View: OLED light engines



	Philips (now OLEDWorks)	Osram	Kaneka	Konica Minolta	LG	OLEDWorks
Efficiency lm/W	50	40 (70)	50	45	60 (80)	50 (80)
L70 Khrs	10 @ 9000nits	10 @ 2000nits (20@3000nits)	30 @ 3000nits	8 @ 1000nits	40 @ 3000nits	12 @ 3000nits (30 @ 3000nits)
CRI	>80	>75	>80	>75	>90	>84
	High brightness	Transportation	Architectural	Flexible	Broad Portfolio	Versatile Mfg

- Are OLED lighting panels positioned for market adoption?
- ✓ Yes, surpass threshold for many applications

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# Why OLEDWorks and Philips OLED?

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- The OLED lighting market is real and growing
- Synergy between OLEDWorks and Philips is compelling
  - Depth and Breadth of OLED expertise
  - Entrepreneurial and innovative approaches to *affordable* manufacturing processes
    - ✓ High volume production capacity in Aachen
    - ✓ Nimble, versatile production in Rochester
  - Combined, product platforms address wider market space

# Summary of Philips OLED Acquisition

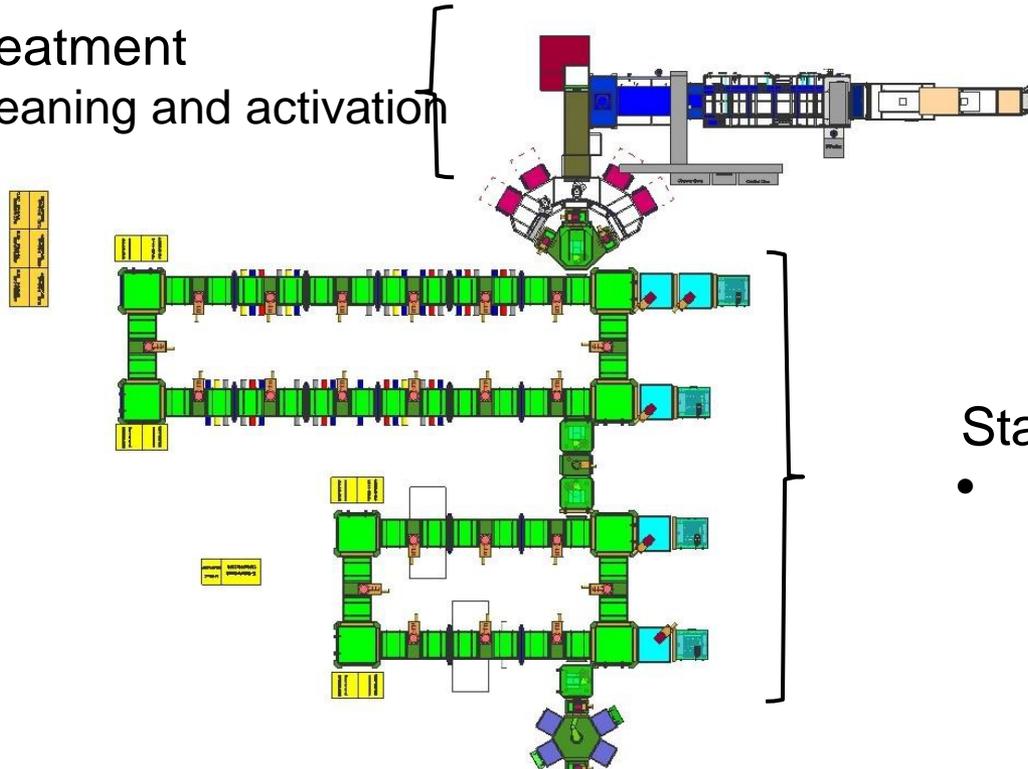
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- Acquired all of the Philips OLED equipment, inventory and other tangible assets
- Existing product portfolio of commercialized products – FL300, FL300L
- Acquired OLED lighting patents
- Retained world class OLED experts covering the following areas-
  - ✓ Manufacturing, ISO
  - ✓ Quality and reliability
  - ✓ Development
  - ✓ Sales and marketing
  - ✓ Administration
- Strategic relationship with Philips®

# Why OLEDWorks and Philips OLED?

## Pretreatment

- Cleaning and activation



## Stack deposition

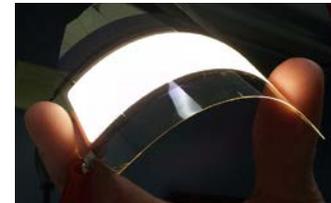
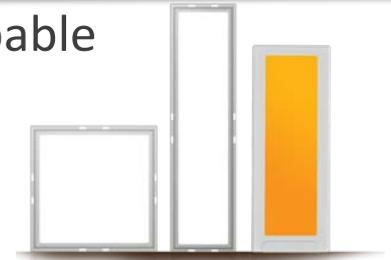
- Vacuum thermal evaporation through shadow mask

## Encapsulation

- Thin-film

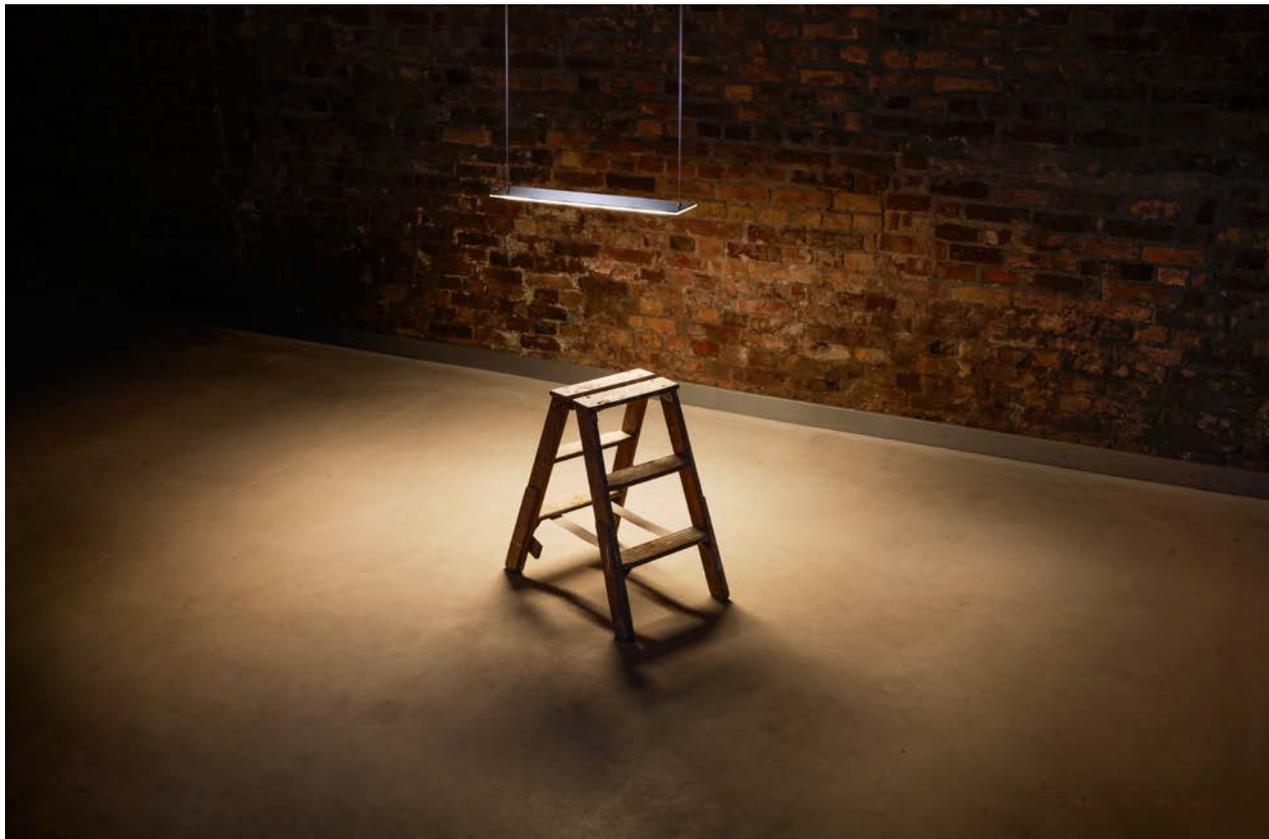
# OLEDWorks Capabilities

- Commercialized product offerings, all high brightness capable
  - ✓ White – FL300, FL300L
  - ✓ Amber
  - ✓ New products will be announced at Light + Building!
- Manufacturing Capacity
- Research and Development
  - ✓ Significant and cost-effective research and development capabilities
  - ✓ Qualified DOE OLED testing facility
  - ✓ Tons of collaboration ongoing, a key to success in the U.S. and Europe
- Joint Development Agreements
  - ✓ Corning® – Willow® Glass
  - ✓ Philips® - Luminaires integrating bendable OLEDs



# What do people love about OLED lighting?

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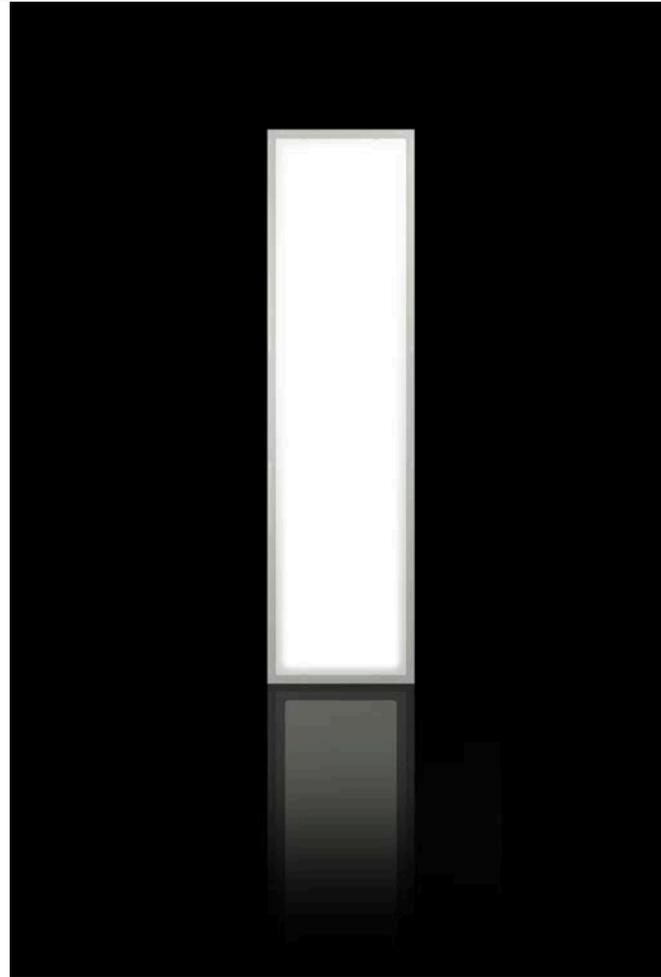
# What do people love about OLED lighting?

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**Thin Planar  
Light  
Source**

**Naturally  
diffuse**

**Excellent  
Color  
rendering**



**Low  
Glare**

**Cool to the  
Touch**

**Solid-State  
Efficient and  
Controllable**

# What do people love about OLED lighting?

---

**Thin Planar  
Light  
Source**

**Naturally  
diffuse**

**Excellent  
Color  
rendering**

**It is the experience. The light quality is beautiful.**

**Low  
Glare**

**Cool to the  
Touch**

**Solid-State  
Efficient and  
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# OLED Lighting Business - The Four “A’s”

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- Awareness
- Adaptability
- Availability
- Affordability

# Awareness

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- Government partnerships
  - DOE Funded Gateway Projects
  - NYSERDA Demonstration Projects
  - Government sponsored rebate programs
  - Integrated Photonics Institute for Manufacturing Innovation
- Designers, architects and other influencers
- OEMs
- Social media
- Retail presence
- Supply chain to customer

# Adaptability

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- Easy to integrate into fixtures
- Use as a building material
- Qualifications for multiple markets

# Availability

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- Make readily available for general consumer
- Sufficient selection of finished luminaires
- OLED tuned drivers
- Access through the entire supply chain

# Affordability

## OLED Cost Reduction

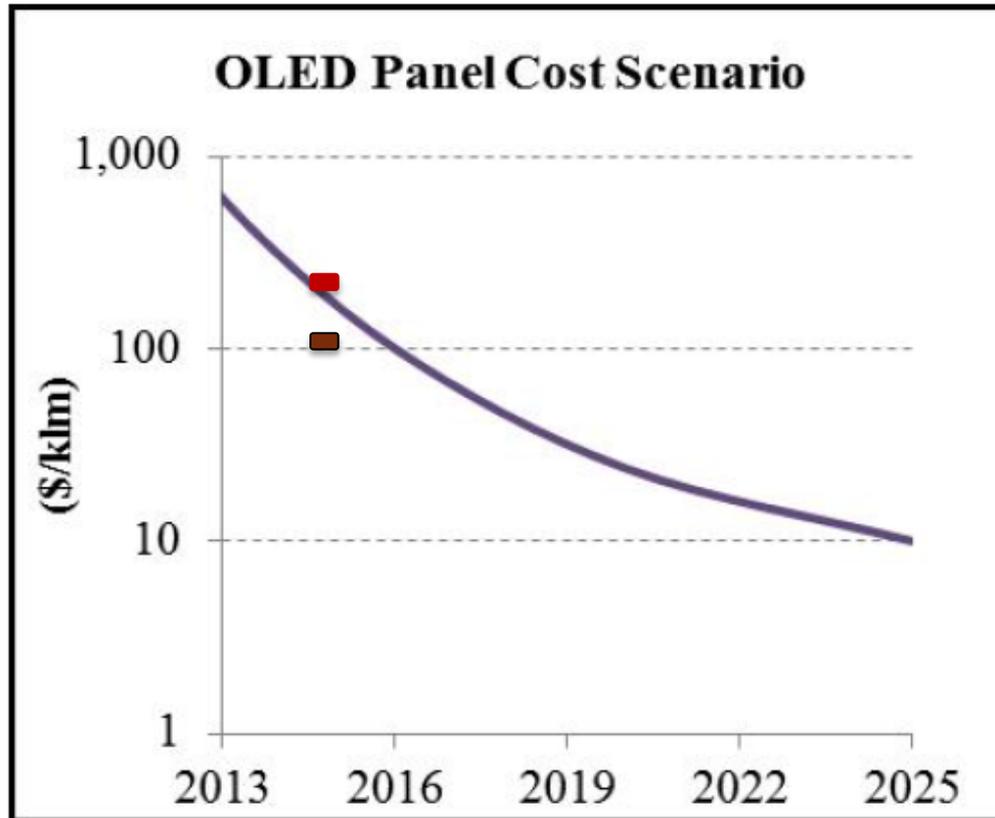
Table 6.4 Estimated Cost of Panels Produced by Traditional Methods

	2014	2015	2017	2020	2025
Substrate Area (m <sup>2</sup> )	0.17	0.17	1.38	2.7	5.5
Capital Cost (\$M)	75	75	200	300	400
Cycle Time (minutes)	3	2	1.5	1	1
Capacity (1000m <sup>2</sup> /year)	14	25	300	1,000	2,400
Depreciation (\$/m <sup>2</sup> )	1,050	600	125	60	35
Organic Materials	200	150	100	35	15
Inorganic Materials	200	200	120	50	30
Labor	150	100	20	10	5
Other Fixed Costs	75	50	15	10	5
Total (unyielded) (\$/m <sup>2</sup> )	1,675	1,100	355	160	90
Yield of Good Product (%)	50	60	70	80	90
<b>Total Cost (\$/m<sup>2</sup>)</b>	<b>3,350</b>	<b>1,850</b>	<b>550</b>	<b>200</b>	<b>100</b>

Source: 2015 DOE Solid-State Lighting Plan

# Affordability

## OLED Cost Reduction



Executive Summary, 2014 SSL R&D Manufacturing Roadmap: [www.ssl.energy.gov/techroadmaps.html](http://www.ssl.energy.gov/techroadmaps.html)

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**OLEDWorks**  
Naturally Illuminating

# Affordability

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- Consider total cost
  - No need for heat sinks, optics, etc.
  - Can bring light closer to user, efficient use of light in many applications
  - Many applications don't need very high lumen output with focused beams
    - ✓ *It is not all about \$/klm*
  - Faster product development cycle
- Many fixtures now very cost competitive

# 2016 and Beyond – Why We ALL will Love OLED

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*The Key to Success is Collaboration!*