

OLED Lighting in the Offices of Aurora Lighting Design, Inc.



DOE Booth
LightFair April 2016

GATEWAY
Demonstrations

Naomi J. Miller, Designer/Scientist
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Leslie North, Designer/Principal
Aurora Lighting Design, Inc.



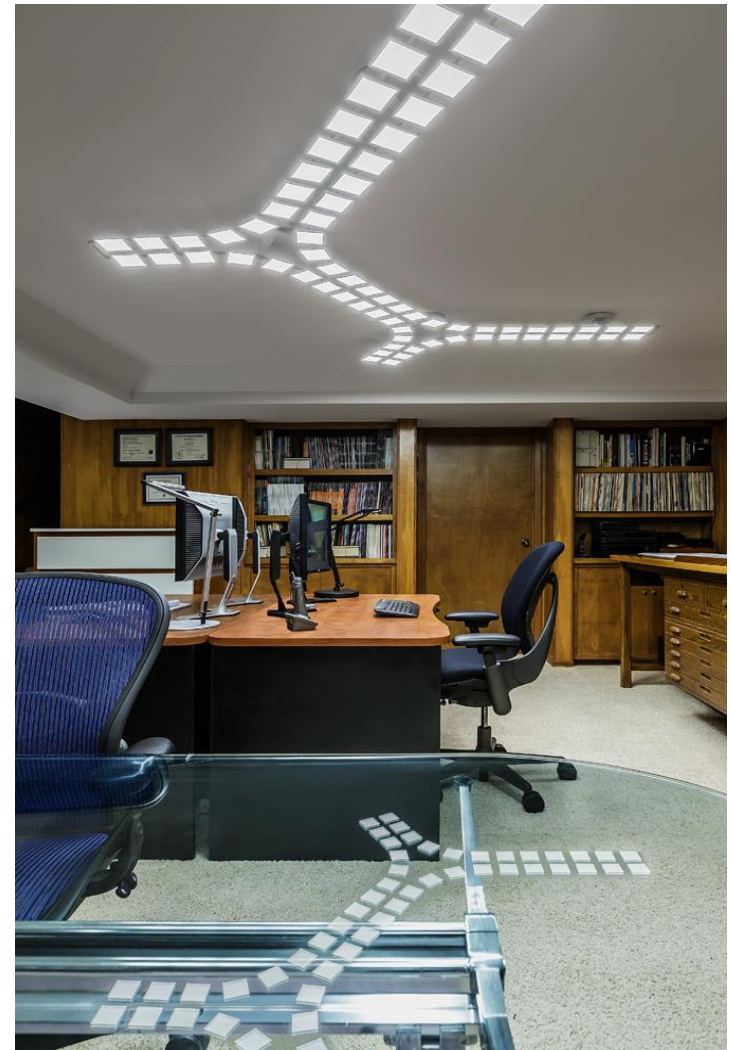
OLED Lighting at Aurora Lighting Design, Inc.

Project description

- Arch'l Lighting Design Office in lower levels of residence in Grayslake IL
- Windows onto lake with daylight as principal light source
- Low gypboard ceilings 7'-5" max with 7" recess depth
- Remodeled lighting in September 2014
- First office test site for OLEDs used in general lighting
- Principal, plus 3 design staff in office

Design criteria

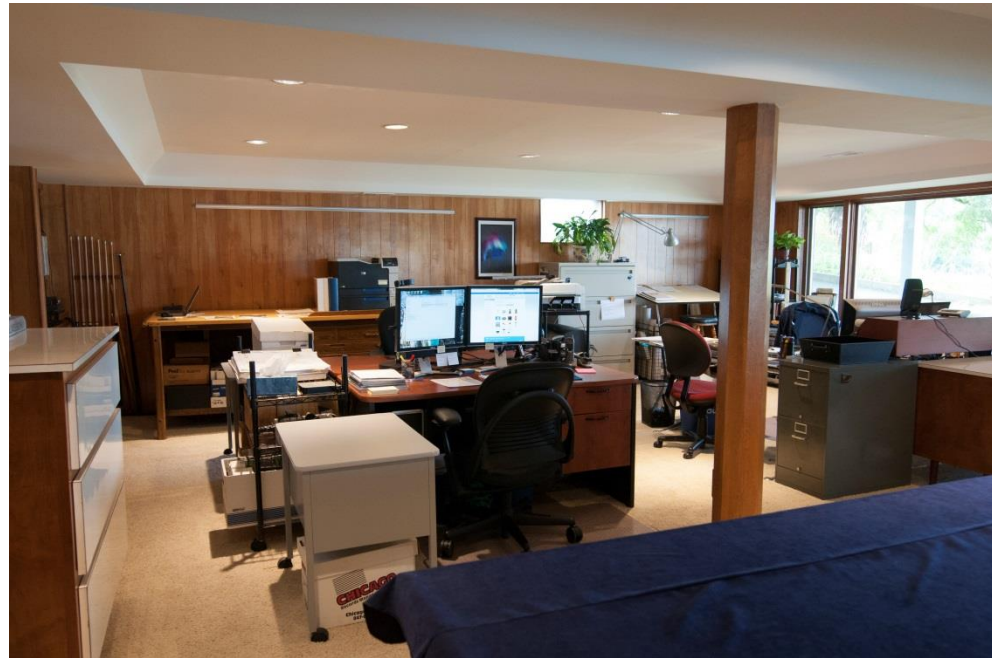
- Warm, home-like 3000K color, 80+ CRI, R9 >20
- Smooth dimming down to 10% output
- Soft appearance and shallow profile
- Average 30+ fc (300 lx) on 30" work plane
- Visually comfortable system with little computer screen glare
- Playful, decorative appearance expressing design, suitable for home resale if needed



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Lighting *before* renovation

- Room is 14'-9" x 20'-6"
- 8 recessed medium-base downlights with screwbase 20W LED PAR30 NFL lamps
- 3000K, 80+ CRI
- 8400 initial lamp lumens total
- 156 system Watts, 0.52 W/sf
- Average 291 lx (27 fc), ranging from 26 to 2087 lx (2 to 194 fc)
LUMPY LIGHTING!
- Narrow beam lamps produce funky shadows on faces
- Dimmable with phase-cut wall dimmer



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Lighting *after* renovation

- Leslie North and Ashley Mikels designed
- Configuration of Acuity Brands Trilia™ lighting system with OLED panels
- 4 triangular + 3 straight assemblies, 3000 K
- 120 OLED panels, 100 mm sq. (4" x 4")
- Each OLED panel produces ~70 lumens, draws ~ 1.6W avg.
- Diffuse light, 3000 cd/m² panel luminance

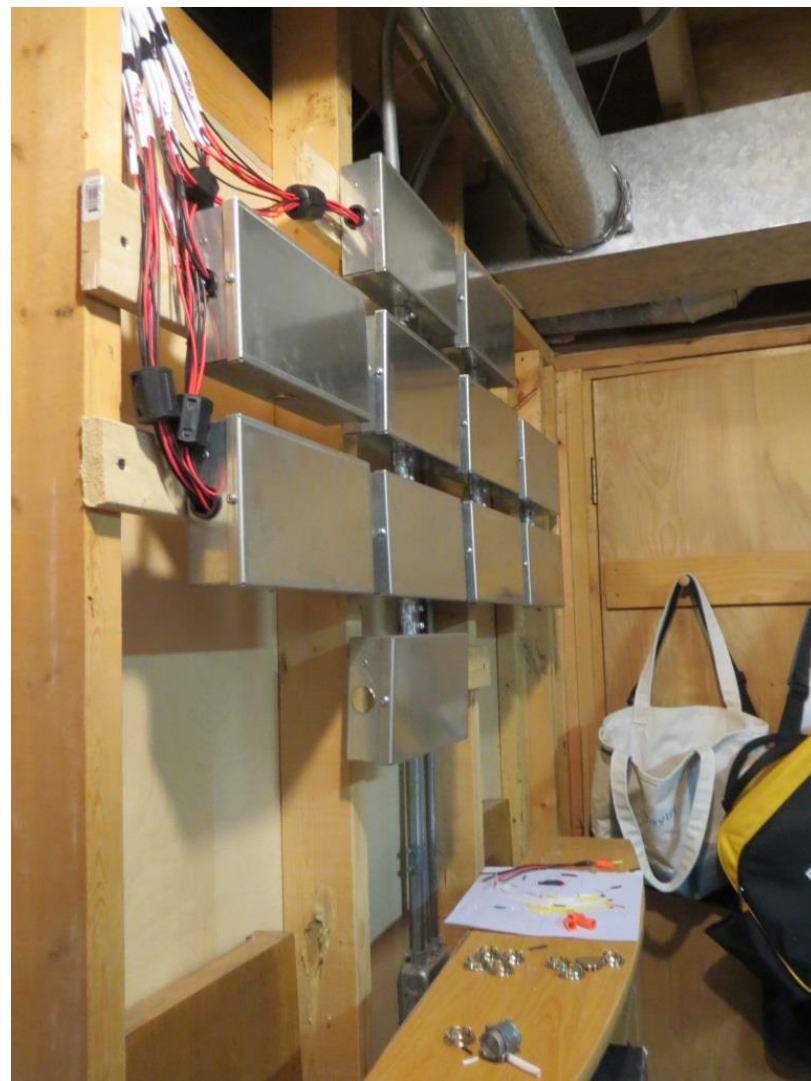


Principal office space
Photo courtesy Acuity Brands

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Lighting *after* renovation

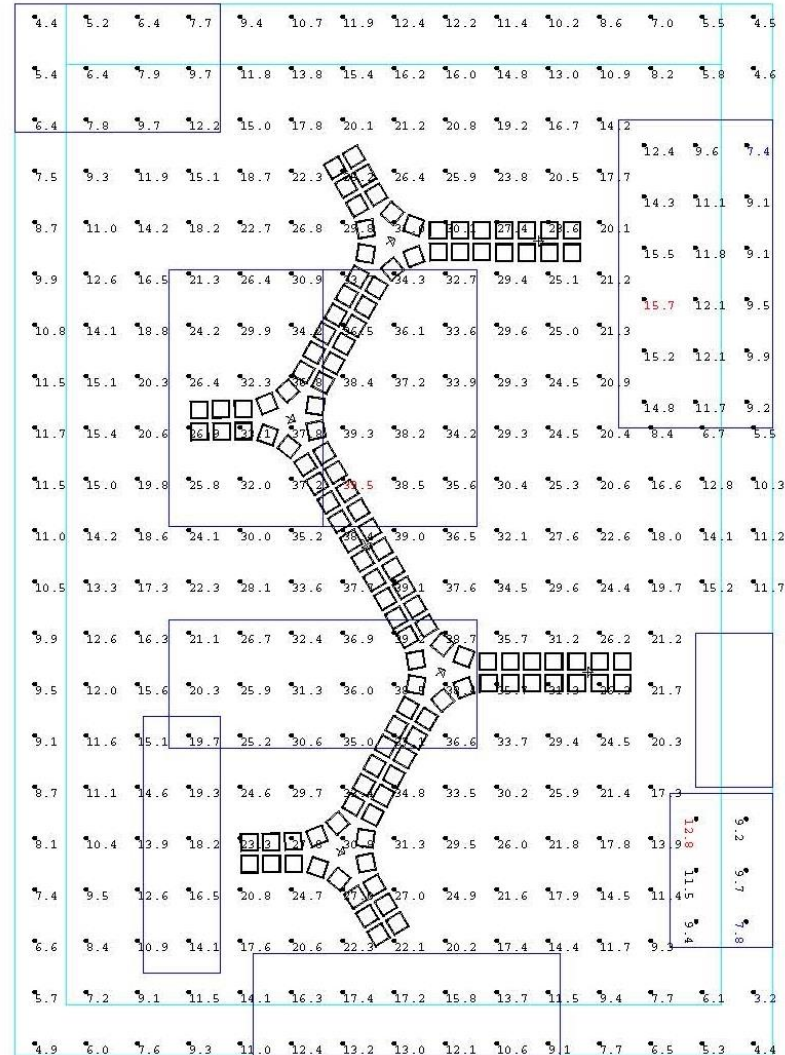
- 11 remote drivers mounted in adjacent storage space
- 8518 lumens at full, per mfr's literature
- 0-10V dimming driver controlled with wall dimmer



Remote-mount drivers in adjacent space
Photos courtesy Aurora Lighting Design, Inc.

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- Calculated light levels using AGI32™
- In footcandles (multiply by 10.76 for lux)



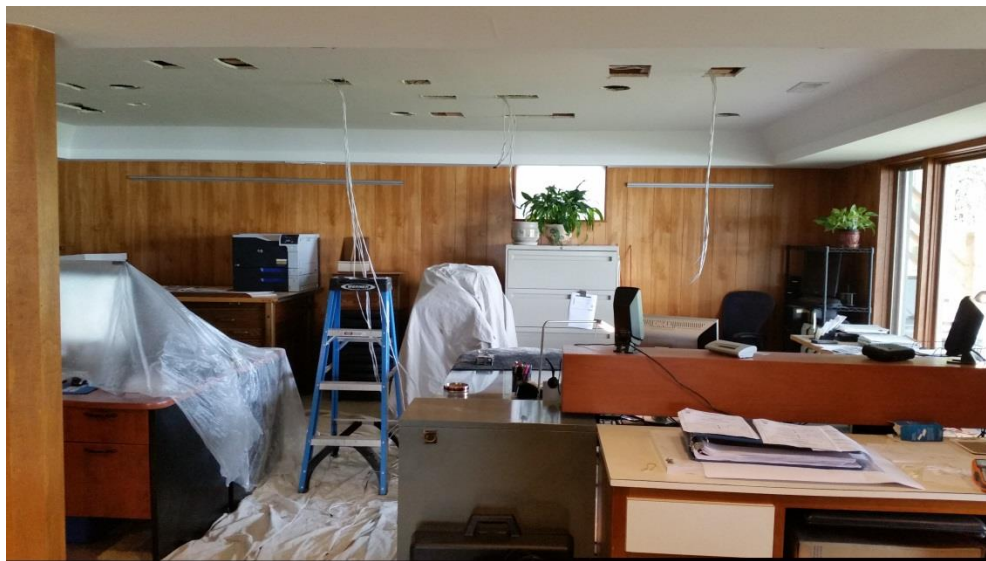
Calculated workplane illuminances in fc,
0.85 LLF

Calculation courtesy Aurora Ltg Design, Inc.

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Installation issues

- Inaccessible ceiling made it impossible to mount boxy drivers above gypboard between joists. Also hard to fish wires from drivers to assemblies. (This is often a problem with remote drivers or ballasts)
- System used LED drivers requiring running 41 wires to feed points for the 7 different assemblies
- Installation completed September 30, 2014



Running driver wires to OLED feed locations
Photo courtesy Aurora Ltg Design, Inc.

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Field issues

- A driver fails two months later, leaving half of a triangular section out. Replacement driver is promptly shipped and installed.
- January 2015, one OLED panel failed to light, and the panel exhibited a dark spot, indicated a shorting defect during manufacturing. Replacement panel was shipped out with video instructions, and Aurora staff replaced it.



Two field issues
Photo courtesy Aurora Ltg Design, Inc.

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Field issues

- Staff almost always uses system in dimmed mode, and had noticed some flicker.
- Tested with flicker top, the OLED system exhibits a pattern suggesting some stroboscopic flicker, likely due to the PWM operation of the dimming driver.
- Acuity's Horizon Team measured 77% flicker at 261 Hz when dimmed to 80%; 100% flicker at 261 Hz at 50% output. These are within the ranges that some people will find visible. Staff reported no adverse health effects.
- Acuity is changing its drivers as a result.



Flicker top showing stroboscopic effect
Photo courtesy Aurora Ltg Design, Inc.

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Reaction from office occupants

- Staff very pleased with finished appearance and function of the OLED system.
- Comments
- Produces almost shadow-free ambient lighting, similar to indirect.
- Using 100% OLED is not very *exciting* in a space. Too diffuse. Few shadows or highlighting.
- Works best if supplemented with task lighting and an accent lighting layer
- At full output, the OLED panels are somewhat uncomfortably bright. When dimmed, they are fine.
- They really appreciate the color quality

Soft

Visitors are intrigued

DESIRABLE UNIFORMITY

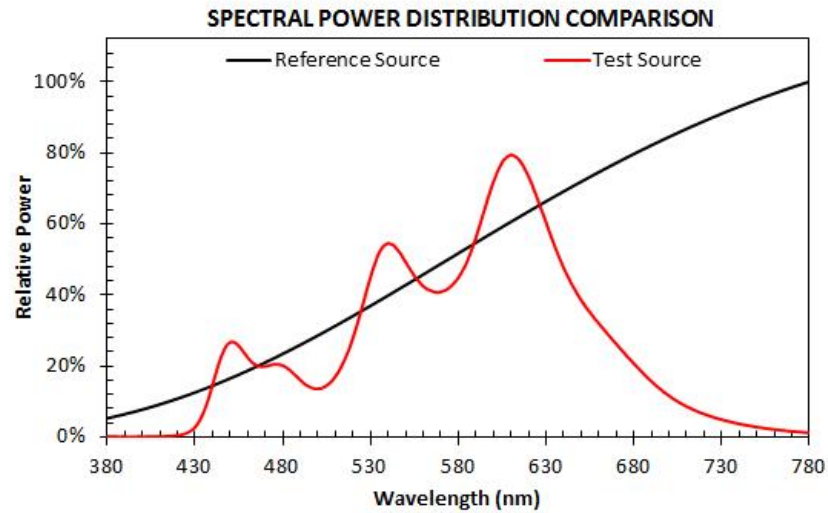
Visitors want to touch the light

Inspiring

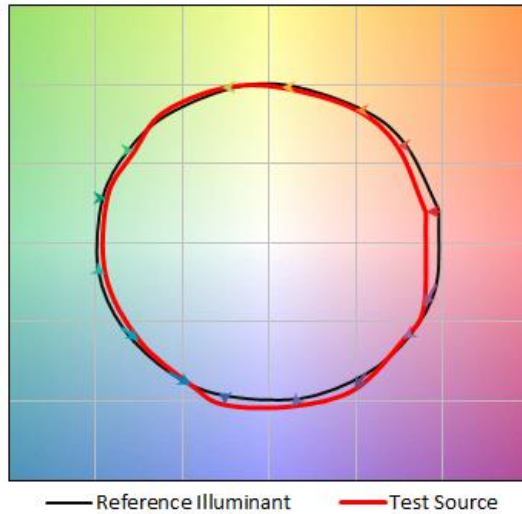
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Color quality of the OLED panels (IES TM-30-15)

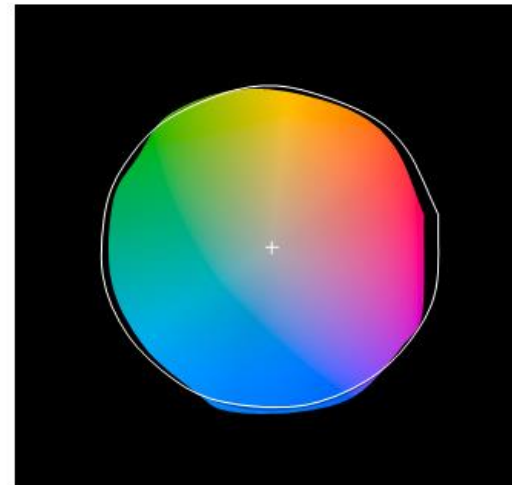
R_f	86
R_g	98
CCT (K)	2974
D_{uv}	0.0019
x	0.4417
y	0.4105
CIE R_a	89



COLOR VECTOR GRAPHIC



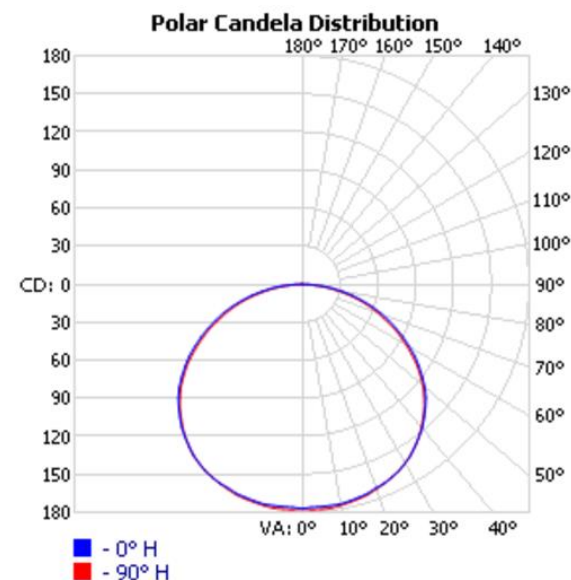
COLOR DISTORTION GRAPHIC



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DOE GATEWAY Program field measurements

- Luminances of panels
 - Panels produce a “cosine distribution” so they theoretically have the same luminance from all viewing angles
 - Luminance meter showed panels ranged from 2625 to 3908 cd/m^2 , even though Acuity claimed a 3000 cd/m^2 maximum for visual comfort.
- Illuminances on workplane
 - Measured workplane illuminances were 20 to 65% higher than calculated (had there been no lumen depreciation, one would expect 18% higher light levels)
- Power draw for system at full output
 - 240 W, assuming a 0.97 PF
 - 0.79 W/sf
 - Expected 192 W per manufacturer’s literature

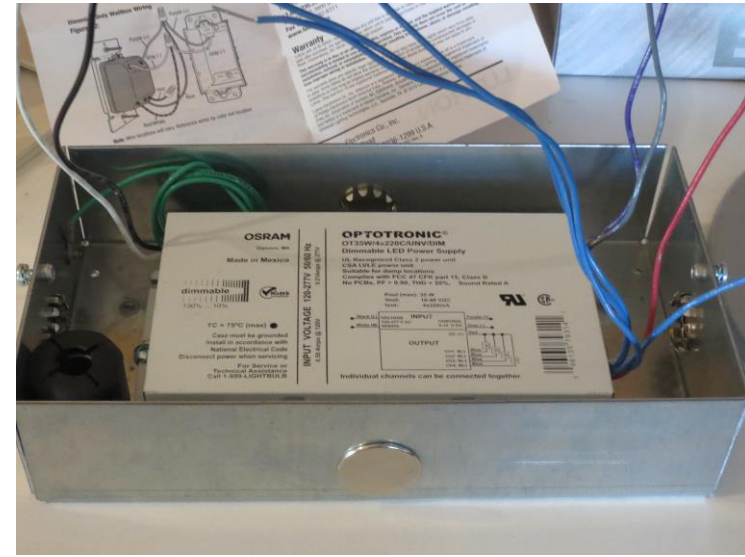


Polar plot of OLED panel light distribution
Image courtesy Acuity Brands

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DOE GATEWAY Program field measurements

- Why the higher-than-expected values?
 - Talk with Acuity's Horizon Group suggests mismatch between specified and installed drivers
 - Aurora Lighting Design, Inc. opens driver boxes to find two 35W drivers out of 11, rather than 25W drivers
- Corrected drivers shipped and installed and follow up spot measurements show illuminances, luminances, and power drop to expected levels
- Power draw for system
 - 189 W, assuming a 0.97 PF
 - 0.62 W/sf
 - 45 lm/W



Incorrect driver installed
Image courtesy Aurora Lighting Design

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Summary of project

- OLEDs are a creative light medium for architectural lighting designers
- They have wonderful properties for facial modeling, cheerful wall luminances, and low-glare ambient lighting
- Growing pains include
 - lower efficacy than LEDs
 - higher cost
 - lack of standardized connectors and mounts
 - limited optical distribution options (at this point in time)
 - and drivers borrowed from the LED industry that are less than optimized for OLED use
- Try them! Gain experience.



Aurora Lighting Design, Inc. Offices
Photo courtesy Acuity Brands

OLED Capabilities, Challenges, Potential

- Exciting design element, especially when panels are easily replaceable
- 20-60 lm/W system efficacy available now. Needs to improve to 100+ to be competitive.
- Panel cost needs to drop precipitously with mass production
- Bendable, foldable, field-cuttable, larger panel options needed for flexibility
- Range of panel luminances and distributions needed
- Drivers! Drivers! Drivers!
 - CCR or hybrid drivers optimized for OLED needs
 - Solve problems of flicker and dimming range
 - Drivers need to be miniaturized to match thinness of panel



Visa Lighting “Limit” pendant
Photo courtesy Visa Lighting



Photo courtesy LG Chem

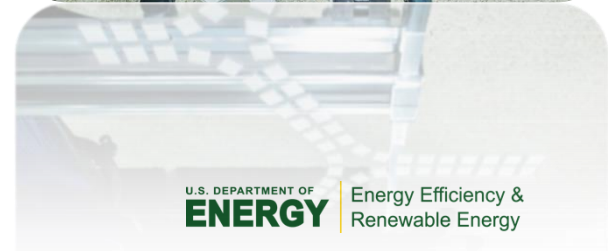
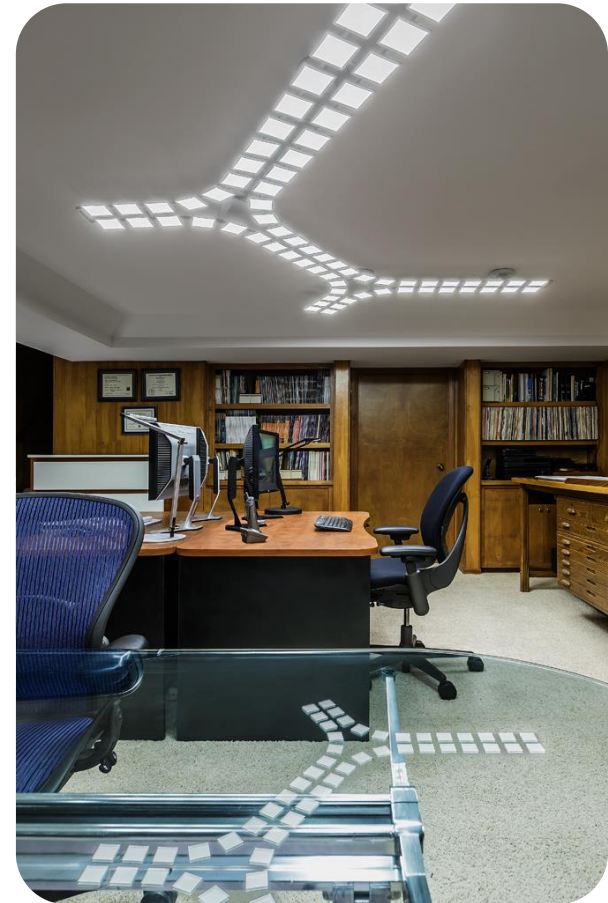
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<http://energy.gov/eere/ssl/gateway-demonstration-indoor-projects>

Thanks for your attention!
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And now for questions????

GATEWAY Demonstrations



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Photos courtesy Acuity Brands