SEPTEMBER/OCTOBER 2009

PennWell

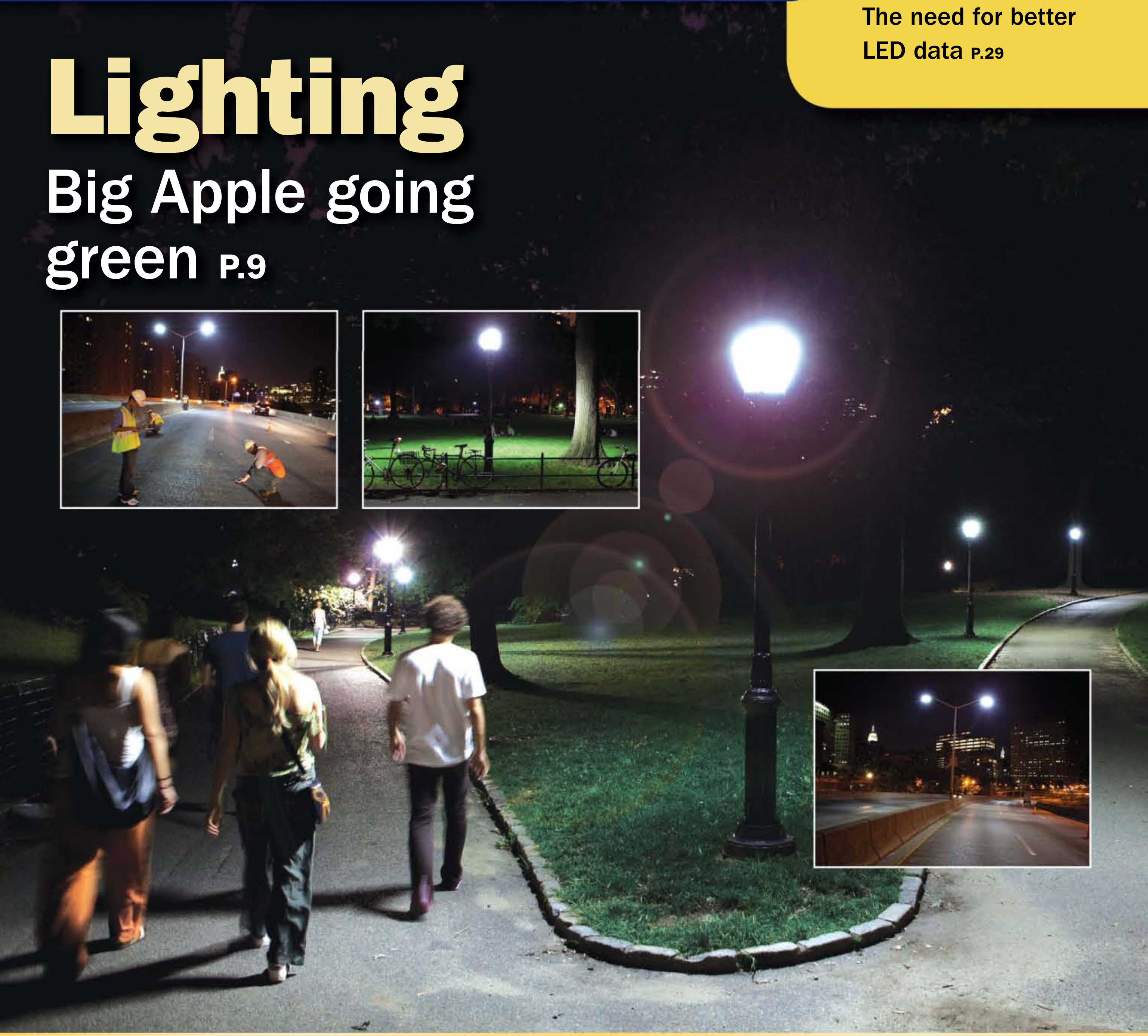
LEDsmagazine.com

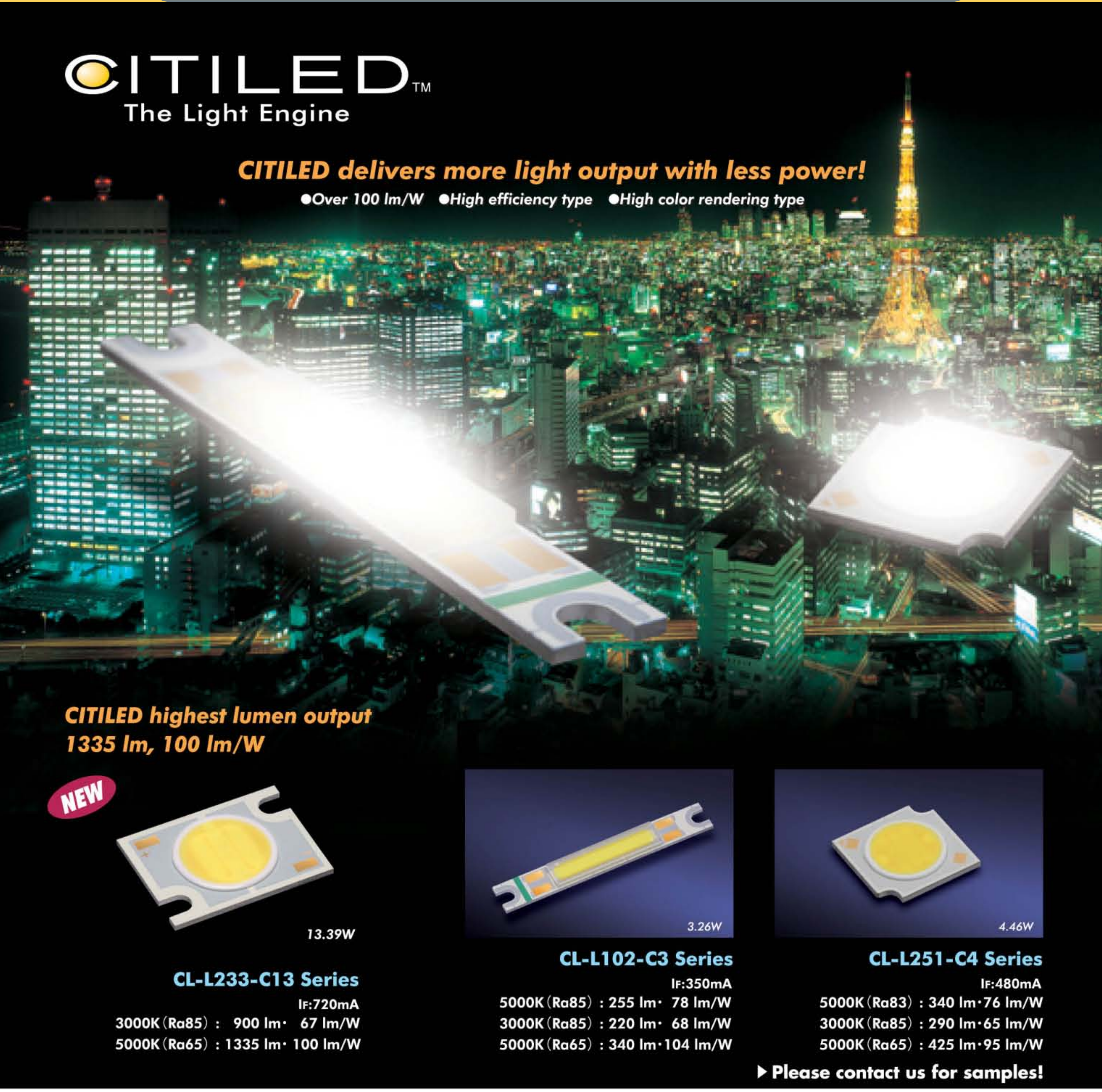
# LEDs MAGAZINE®

TECHNOLOGY AND APPLICATIONS OF LIGHT EMITTING DIODES



## Lighting
Big Apple going green P.9






# CITIZEN ELECTRONICS CO., LTD.

CITIZEN Micro HumanTech

**Distributors**

**Italy : Velco S.p.a.**
Contact person : Paola Tonel Tel : +39-0444-922-922 E-mail : info@velco-electronic.com

**Germany / Austria / Swizerland : Endrich Bauelemente Vertriebs GmbH**
Contact person : Albrecht Lohrer Tel : +49-7452-600756 E-mail : a.lohrer@endrich.com

**England : Marl International Ltd. (Optosource)**
Contact person : Clare Millard Tel : +44-1229-582430 E-mail : clare.millard@optosource.com

**France : Eurocomposant**
Contact person : Patrick Fichot Tel : +33-1-30-64-2602 E-mail : pfichot@eurocomposant.fr

**Spain / Portugal : Antonio Lopez Garrido, S.A.**
Contact person : Jose Luis Garrote Tel : +34-96-192-06-34
E-mail : ventas@algsa.es (for sales) / laboratorio@algsa.es (for technical assistance)

**Scandinavia / Baltic states : Arrant-Light Oy** www.light.fi
Contact person : Janne Makinen Tel : +358-2-2462-300 E-mail : janne.makinen@light.fi

**Belgium / Netherlands / Luxembourg : Elincom Electronics B. V.**
Contact person : Michiel Wubs Tel : +31-10-264-0270 E-mail : m.wubs@elincom.nl

Please contact us for distributors in other countries.

**Contact**

| | |
|---|---|
| Europe | Tel : +49-69-2992-4810 |
| North America | Tel : +1-847-619-6700 |
| Japan | Tel : +81-3-3493-2716 |
| Asia | Tel : +852-2793-0613 |
| Other area | inquiry@ce.citizen.co.jp |

● Request / Inquiry
**E-mail : inquiry@ce.citizen.co.jp**

**Website : http://ce.citizen.co.jp/e**


• Superb LED Lighting by XLEDs, Korea
2710TC 9W 90~245V 540Lm 160Lx
Replaces PAR-30 75W 75W → 20W
GA3022S
20W
90~245V
840Lm
1415Lux
Replaces MR-16 50W 50W → 8W
GA1607S
8W
12V
280Lm
440Lux
LED Desk Lamp 20W → 10W
3 Color Mode
Q-200
10W
12V
1400Lux
Replaces M250 250W → 120W
Cobrahead
SL-L1
120W
90~280V
8900Lm
Light Temptation
CE
c UL us
ENERGY STAR PARTNER
XLEDs
XLEDs marketing strategy -Strategic alliance -Integrated support for project business -General dealers
Please contact Dohyeon B/D 4F #128-6 Nonhyeon-dong, Kangnam-Gu, Seoul Korea,
www.exleds.com Tel : 82-2-3443-5360 ext 309 E-mail : info@daejindmp.co.kr

LEDs MAGAZINE® ISSUE 29

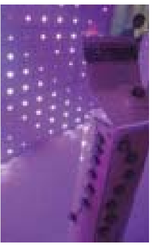
september/october 2009

## Cover Story

*The City of New York has commenced trials of LED fixtures from nine manufacturers at locations in Central Park and on the FDR Drive (see p.9). Photo credit: Ryan Pyle.*

## features











## columns/departments

commentary

# Philips eyes the prize for LED lamps

The US Department of Energy (DOE) has received, from Philips, the first submission for the Bright Tomorrow Lighting Prize, usually known as the L Prize. The lamp, an LED replacement for a 60W incandescent, will now be extensively tested to see if meets the competition requirements, such as producing 900 lm using less than 10W. Performance testing by independent laboratories will be followed by long-term lumen maintenance testing and field assessments. As well as receiving cash, the winning entries in each of three categories will be considered for federal purchasing programs and utility incentive programs — these should prove to be the real prize. The fanfare surrounding the Philips submission should not disguise the fact that this is not a "done deal" — entries will be accepted in this and other product categories until a winner is declared, which presumably will not happen until the winners are commercially available in volume, rather than being prototypes with best-possible performance.

Another DOE program is the Quality Advocates pledge and the Lighting Facts labeling scheme. Partners sign up voluntarily by taking the pledge, and then submit their products along with performance data measured according to LM-79. Once the data has been scrutinized, a Lighting Facts label is issued, which contains key performance data and is designed to give purchasers confidence that the product will operate according to the claims made on its packaging. We've all seen labels that say things like "14W compact fluorescent replaces 75W incandescent." Unlike such claims, the Lighting Facts labels are backed by facts and can be believed. Enter Philips, which risked undermining all this good work. Philips LED lamps carrying Lighting Facts labels went on sale in The Home Depot, a major US retail store. Unfortunately the Philips lamps group had not signed up to the DOE's program, and had simply created its own replica Lighting Facts labels for the packaging. The problem was brought to the DOE's attention by a rival manufacturer. Philips apologized, blaming an internal procedural error, and joined the program, submitting its LED lamp data retrospectively. DOE has not yet explained what action it might take.

Around the same time, at an analyst day, Rudy Provoost, CEO of Philips Lighting, highlighted how the continuing advancements in LED lighting will result in industry growth. For lighting applications, Philips predicts an overall growth in market volume and value between 2008 and 2020, driven by increasing demand for all-inclusive, tailor-made solutions. LED-based applications will capture a rapidly growing share of the market since they offer increased possibilities for customers, such as intelligent control, dynamic ambience and improved total cost of ownership. In turn, this will trigger a higher willingness to invest.

For lamps, Philips forecasts a steady decline in unit sales due to the replacement of conventional lamps by LED lamps with longer lifespan. However, the market value of lamp sales will grow significantly because retrofit LED lamps have higher prices, which can be justified by longer lifespan and energy savings. Philips' predictions show that LED lamps will take the lion's share of the market by 2020, so clearly its commitment in this area goes way beyond trying to snag the L Prize.

Tim Whitaker, EDITOR
*twhitaker@pennwell.com*

LEDs MAGAZINE®

GROUP PUBLISHER Christine Shaw
cshaw@pennwell.com
EDITOR Tim Whitaker
twhitaker@pennwell.com
Tel. +44(0)117 946 7262
MANAGING EDITOR Carol Settino
carols@pennwell.com
Tel. +1 603 891 9234
CONTRIBUTING EDITORS Brian Owen
MARKETING MANAGER Luba Hrynyk
PRESENTATION MANAGER Cindy Chamberlin
PRODUCTION DIRECTOR Mari Rodriguez
SENIOR ILLUSTRATOR Christopher Hipp
AUDIENCE DEVELOPMENT Debbie Bouley

PennWell®

EDITORIAL OFFICES PennWell Corporation, LEDs Magazine Corporate Offices
98 Spit Brook Road, LL-1
Nashua, NH 03062-5737
Tel: +1 603 891-0123
Fax: +1 603 891-0574
www.ledsmagazine.com

SALES OFFICES
SALES MANAGER (USA) Mary Donnelly
maryd@pennwell.com
Tel. +1 603 891 9398
SALES MANAGER (EUROPE) Joanna Hook
joannah@pennwell.com
Tel. +44(0)117 946 7262
SALES MANAGER (JAPAN) Manami Konishi
manami@ics-inc.co.jp
Tel: +81 3 3219 3641
SALES MANAGER (CHINA & HONG KONG) Mark Mak
markm@actintl.com.hk
Tel: +852 2838 6298
SALES MANAGER (TAIWAN) Alice Chen
alice@arco.com.tw
Tel: +886 2 2396 5128 ext.206

CORPORATE OFFICERS
CHAIRMAN Frank T. Lauinger
PRESIDENT AND CEO Robert F. Biolchini
CHIEF FINANCIAL OFFICER Mark C. Wilmoth

TECHNOLOGY GROUP
SENIOR VICE PRESIDENT Christine A. Shaw
SENOIR VP OF AUDIENCE DEVELOPMENT Gloria S. Adams
VP INTERNET SERVICES Tom Cintorino

SUBSCRIPTIONS: For subscription inquiries:
Tel: +1 847 559-7330;
Fax: +1 847 291-4816;
e-mail: led@omeda.com;
ledsmagazine.com/subscribe

www.sylvania.com/LED


# LED system solutions *start* with SYLVANIA.

SYLVANIA, together with OSRAM Opto Semiconductors, brings you specialized LED solutions. The combined expertise of two industry leaders ensures that every detail of your LED system development is in good hands, from concept through installation and field service support. SYLVANIA's innovative business approach gives you the edge, and our system support and 5-year product warranty gives you continued confidence in our services.

For more information, call 1-800-LIGHTBULB or visit us at www.sylvania.com/LED.

OSRAM Opto Semiconductors

SYLVANIA

## LEDs MAGAZINE *online*

### *Webcasts*

**Optimizing LED Performance through Heat Management**

**DATE:** October 29, 2009

**PRESENTERS:** Martin Schon, Sapa Extrusions; Mick Wilcox, Nuventix

**Solid-State Lighting: Safety Certification Process and Performance Testing Measurement Techniques**

**ORIGINALLY BROADAST:** September 2009

**PRESENTERS:** Greg McKee, Labsphere
Todd Straka, Intertek

Visit www.ledsmagazine.com/webcasts to access upcoming and archived presentations.

### *Web Exclusive Articles*

Investors meet technologists in Chicago
www.ledsmagazine.com/features/6/8/8

Reading between the lines: How to make accurate performance assessments from a power LED datasheet
www.ledsmagazine.com/features/6/8/10

A healthy amount of research still required
www.ledsmagazine.com/features/6/8/9

Strategically Speaking: Forecasting the LED Lighting Market
www.ledsmagazine.com/features/6/7/4

From the Street (and Area Lighting Conference)
www.ledsmagazine.com/features/6/9/4

## ADVERTISERS *index*



## FEATURED *events*

Strategies in Light 2010

Strategies in Light — The Leading Events for the Global LED and Lighting Industry

**February 10-12, 2010**
*Santa Clara, California, USA*

LED Japan 2010/Strategies in Light
**September 28-29, 2010**
*Yokohama, Japan*

Strategies in Light Europe 2010
**September 28-29, 2010**
*Frankfurt, Germany*

*MORE: www.strategiesinlight.com*

Light Emitting Diodes 2009
**October 20-22, 2009**
*San Diego, CA, United States*

Hong Kong International Lighting Fair
**October 27-30, 2009**
*Hong Kong Convention & Exhibition Centre*

Professional Lighting Designers Convention
**October 28-31, 2009**
*Berlin, Germany*

3rd International LED Forum
**November 11-12, 2009**
*Moscow, Russia*

LDI 2009
**November 19-22, 2009**
*Orlando, Florida, United States*

OLED Lighting Design Summit
**December 2-3, 2009**
*Boston, MA, United States*

ForumLED
**December 3-4, 2009**
*Lyon, France*

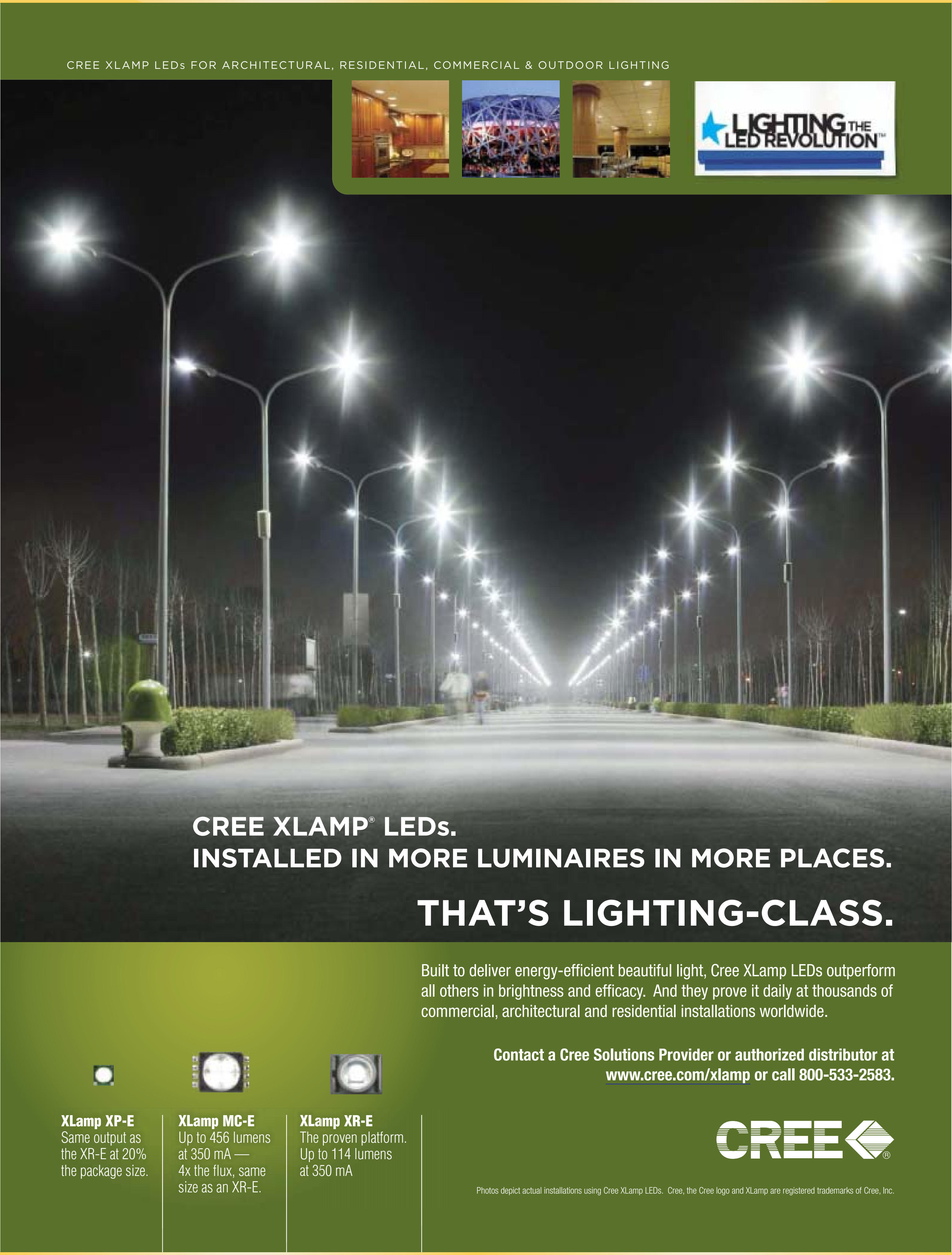
White LEDs
**December 13-16, 2009**
*Taipei, Taiwan*

*MORE: www.ledsmagazine.com/events*

### *Featured Companies*

*The following have recently been added to the LEDs Magazine site as Featured Companies (see www.ledsmagazine.com/buyers/featured):*

Glacial Light • EnergyLED Corp • Aeon Lighting Technology • Cree Inc. • Infineon Technologies • Stanley Electric


CREE XLAMP LEDs FOR ARCHITECTURAL, RESIDENTIAL, COMMERCIAL & OUTDOOR LIGHTING
LIGHTING THE LED REVOLUTION™
CREE XLAMP® LEDs.
INSTALLED IN MORE LUMINAIRES IN MORE PLACES.
THAT'S LIGHTING-CLASS.
Built to deliver energy-efficient beautiful light, Cree XLamp LEDs outperform all others in brightness and efficacy. And they prove it daily at thousands of commercial, architectural and residential installations worldwide.
Contact a Cree Solutions Provider or authorized distributor at www.cree.com/xlamp or call 800-533-2583.
XLamp XP-E
Same output as the XR-E at 20% the package size.
XLamp MC-E
Up to 456 lumens at 350 mA — 4x the flux, same size as an XR-E.
XLamp XR-E
The proven platform. Up to 114 lumens at 350 mA
CREE®
Photos depict actual installations using Cree XLamp LEDs. Cree, the Cree logo and XLamp are registered trademarks of Cree, Inc.

# news views

OUTDOOR LIGHTING

## Big Apple goes green with LED pilot projects

The New York City Department of Transportation (NYCDOT), in partnership with international nongovernmental organization The Climate Group, has launched its first LED lighting pilot tests in two of the city's iconic urban settings: Central Park and the FDR Drive roadway. Both locations are under evaluation by the US Department of Energy's (DOE) Gateway program, whose purpose is to provide independent, third-party evaluation of LED products installed in real-world applications.

The LED pilot projects will quantify the financial savings and performance of LEDs while visibly demonstrating the improved illumination for Central Park's 25 million visitors and FDR Drive's 150,000 daily drivers. The City will gather reliable data on the lifespan, power consumption, and lighting » page 10

**The Los Angeles Bureau of Street Lighting says that it has started replacing existing streetlight fixtures with LED units. The photo shows the 6th Street Bridge over the Los Angeles river with high-pressure sodium lights (top) and with LED fixtures (bottom). BetaLED, one of the approved suppliers to the New York City pilot test, said it has shipped 4,000 fixtures so far, and about 1,000 of them have already been installed.**

**MORE:** www.ledsmagazine.com/news/6/9/22.

BACKLIGHTS

## Samsung asked to stop using the term 'LED TV' in adverts

The Advertising Standards Authority (ASA) in the UK has upheld complaints that advertisements for Samsung's LED-backlit LCD televisions, in which the company uses the phrase "LED TV," are misleading. In its adjudication, the ASA stated, "We considered that the ad implied the TV displays were comprised totally of LEDs similar to some outdoor displays when that was not the case. We considered that because the ads were ambiguous and did not make clear how the TVs utilized the LED technology, the ads were likely to mislead." The ASA has ruled that the ads must not appear again in the UK market in their current form. Samsung has been told to ensure that future marketing communications describe the technology their products use accurately. LEDs Magazine highlighted this situation in its July/August issue, when we said on page 4, "The term 'LED TV' is a little controversial, and in the UK it is being looked at by the ASA. Of course, Samsung doesn't actually make LED TVs, and is in fact talking about its new LCD TVs with LED backlights." ◂

**MORE:** www.ledsmagazine.com/news/6/9/5

PATENTS

## Philips and Lighting Science Group settle LED litigation

Lighting Science Group Corporation (LSG) and Royal Philips Electronics have settled all of their commercial and intellectual property disputes by way of a comprehensive agreement that revives the former commercial alliance between the companies. Not surprisingly, LSG has taken out a royalty-bearing license to the Philips LED-based Luminaires and Retrofit Bulbs licensing program (see also www.ledsmagazine.com/news/6/8/10). Also, Philips will make a $5 million equity investment in LSG, which is publicly traded. The agreement also calls for "intensification in trade in LED lighting products" between the companies involving mutual sourcing and supplying of LED components and products. All intellectual property (IP) and commercial claims between the companies, and all pending lawsuits, have been dismissed.

The dispute between LSG and Philips dates » page 11

*Big Apple from page 9*

performance of nine different LED products over a 12-month test period. Products undergoing testing in Central Park are those from King Luminaire, Lumec, Sentry, Spring City, and Sylvania, while the suppliers of products on the FDR Drive are BetaLED, eLumen, LED Roadway Lighting, and LSI.

As part of The Climate Group's global LED pilot program, a partnership of more than 10 major cities including London and Mumbai, New York is the first to begin pilot testing. Dasha Rettew, who leads The Climate Group's US Cities & Technology Program said, "By working with the world's largest cities, we will establish a series of outdoor LED pilot tests that will unlock critical data, independent from manufacturers, to demonstrate the real-world return on investment, performance, and carbon saving benefits of this transformative and scalable clean technology." ◂

**MORE:** www.ledsmagazine.com/news/6/9/17

LICENSING

## ilumisys grants IP licenses for LED fluorescent tube replacements

Two Illinois-based lighting manufacturers—LED Lighting and Light Emitting Designs—have licensed patents from ilumisys Inc. that allow them to manufacture LED-based fluorescent tube replacements. Both agreements provide for royalty payments to be made on a per-unit basis in exchange for rights to manufacture and sell products covered by the patents. ilumisys has filed more than 30 patent applications in this area. At the heart of its strong IP position are two initial patents granted in the US.

Ilumisys President Dave Simon said the growth in LED lighting leaves room for a lot of providers with different areas of focus. "By giving licensees access to our expanding patent portfolio we believe that both product development and installation rates will move faster," he said.

The company has also been involved in litigation to protect its IP position, said Simon; some is still open and some has been settled in favor of ilumysis. The company is focused on developing higher-end products for mass-market adoption, rather than trying to maximize sales. "Our licensing program will allow companies to provide products to the market, while enabling ilumisys to continue our R&D efforts aimed at what will be required for truly large-scale adoption over the next few years," said Simon.

Manufacturing issues will be significantly different when these replacement tubes are supplied in the millions. "For example, with current designs, huge quantities of aluminum will be required for heat-sinking, affecting the overall carbon footprint," said Simon. Ilumysis is collaborating on a project with the US National Center for Manufacturing Sciences (NCMS) to look at some of these issues. ◂

**MORE:** www.ledsmagazine.com/news/6/9/20

# OLED Lighting Design Summit Agenda

## Agenda - December 2-3, 2009

### Leading Industry Speakers

Bernhard Dessecker, *Lighting Designer,* **Ingo Maurer**

Brian Terao, *Director of Solid state lighting,* **Osram Opto Semiconductors GmbH**

James R Benya, *Principal,* **Benya Lighting Design**

Oscar Peña, *Senior Creative Director, Lighting,* **Philips Design** - (Tentative)

Peter Ngai, *Vice President of Research and Development,* **Acuity Brands lighting** - (Tentative)

Jed Dorscheimer, *Principal, Sr. Equity Analyst,* **Canaccord Adams**

Avraham Mendall Mor, *Partner,* **Lightswitch Architechural**

Mike Hack, *VP, Strategic Product Development,* **Universal Display Corporation**

Dr Geoff Williams, *OLED Group Leader,* **Thorn Lighting**

Barry Young, *Managing Director,* **OLED Association**

Kristin Knappstein, *Business Development Manager,* **Philips Lighting**

Dr. Dietrich Bertram, *Manager OLED Development,* **Philips Lighting**

Gildas Sorin, *CEO,* **Novaled**

Jennifer Colegrove, *Director of Display Technologies,* **Display search**

Steve Van Slyke, *R&D Director,* **Kodak OLED Systems**

Dr. Y. S. Tyan, *Technical leader, OLED SSL project,* **Kodak OLED systems**

### OLEDs promise and potential for lighting designers

- Limitless lighting possibilities - understand how using OLEDs will open the door to a new creative era of lighting design
- Delve deep into the specifics of the new design capabilities and new challenges that OLED lighting presents and plan ahead so that you can hit the ground running and start using OLEDs with minimum disruption
- Unlocking new revenues - get a glimpse into how you can use OLEDs capabilities and attractive price point to win over new customers and tap into new markets for lighting design
- Understand the full potential for OLEDs - will they be so effective that all users will want to upgrade, creating a massive gold rush for lighting designers?

### Using light in new ways - the OLED Light Designers toolkit

PANEL SESSION

This panel session will discuss how OLEDs will change the way you work with light - hear from industry leading experts on how:

- OLEDs enable light fixtures to be flexible, light weight, transparent and ultra flat - what this means to creative design and what added considerations need to be taken into account for real world installation
- Diffuse area light created by OLEDs removes the need for shades or frosted glass - enabling designers and users to abandon traditional thinking of clustering lights in corners or ceiling centers
- Using OLEDs removes sharp shadows, making light design a breeze for certain demanding applications such as medical operating theaters
- OLEDs low power consumption presents a compelling selling point to environmentally conscious user

### OLED performance pitching - how to impress your clients with the benefits of OLEDs

PANEL SESSION

Through in-depth discussion of the latest OLED benchmarks discover the compelling advantages OLEDS have over existing lighting technologies and how you can use this to win over and delight your clients. Including:

- Low power consumption and operating voltage - minimizing heat and electricity bills
- Outstanding colour variation and spectrum - opening up new and incredible design ideas and fixture possibilities
- Light output, reliability over time and OLED lifespan - the core facts that accounts departments and CFOs everywhere need to know to sign off on new design proposals

### OLEDs - unlocking new applications for lighting design

PANEL SESSION

Get an exclusive and exciting insight into new lighting applications where OLED technology adds incredible value - hear a discussion on what role lighting designers play and how can they profit from:

- Illuminated Outwear and fabric based flexible lighting sources
- Portable lighting and new lamp designs
- Concealed lighting – soft-light retail displays, stage lighting and more
- Digital signage and advertising applications
- Off the shelf decorative lighting products for residential use
- Specialty architectural and industrial lighting

### Why OLEDs will lead the way in lighting

- OLED technology will allow you to install light where it's never existed before, such as in blinds and wallpaper - find out why this true paradigm shift in lighting will deliver lighting solutions customers will love
- Discover in detail the full environmental benefits of OLEDs from efficiency to lack of mercury and other customer critical considerations
- Hear a comparison with inorganic LEDS and find out why OLEDs promise better solutions at a price point that will unlock mass market wallets

**Reserve your place today - call 1800 814 3459**

# Get Unique Insight From Leading OLED Companies

## Agenda - December 2-3, 2009

### Case study - The world's first OLED lamp –

- Hear how leading lighting designers ingo maurer and OLED developer Osram worked together in creating the "Early Future OLED lamp"
- Understand the challenges and pitfalls the team faced in the design process of the lamp and why a lamp design was chosen as a good fit for OLED's
- Learn how this project will light the way towards future innovations in OLED lighting design, and see where they intend to take things next.

### OLED MASTERCLASS Part 1 – OLED components in depth

- Everything you need to know from organic polymers to flexible substrates - gain a designers crash course into the component parts of an OLED system
- Delve deep under the bonnet of an OLED lighting panel and get to grips with how they work - giving you the knowledge you need to integrate them into successful lighting projects
- Multiple dyes, unified glow or point source? Get the answers to the technical OLED questions you need to know to start designing with OLEDs

### OLED MASTERCLASS Part 2 - OLED system constraints

- Operation over time - when you can expect light quality and efficacy to fall off and what design factors can maximize OLED performance
- Power supply management - find out what implications you need to take into account in the design of OLED systems
- Discover the environmental and design conditions under which OLEDs can fail or not operate at optimum ability
- Find out what design considerations need to be met in order to support the installation of OLED component parts
- OLED colour characteristics – discover how to tweak your designs to deliver the most consistent colour output of OLEDs

### The rise and shine of OLED technology – the path to market acceptance

- Evaluate and analyze the future of OLED lighting and gain insight into the applications and environmental regulations that will fuel the market for OLED lighting design in the near future
- Get a glimpse into the wide reaching effect this disruptive technology will have and hear expert predictions on the new ways OLEDs will light our world and what this means to lighting designers
- Uncover what it is really going to take to make OLEDs break out into the mass market and when we can realistically expect to see OLEDs taking a significant share of the lighting market across the US and the world

### Near future expectations for OLED lighting

- Understand the critical role the lighting design community needs to play in nurturing this lighting revolution - both in educating customers and in designing new and appealing lighting solutions

### OLED LIGHTING DESIGN SUMMIT NETWORKING DRINKS PARTY

On the evening of December 2nd, take the opportunity to share a drink with industry leaders and network with your peers. Make vital new contacts and take advantage of this unique opportunity to meet with the cream of the OLED lighting expertise under one roof, for one night only!

### Lighting Designers OLED solutions - round table peer discussions

This is your chance to be an industry pioneer and to help shape the future of OLED for lighting. Each working group discussion will be focused on a vital topic that is crucial to making the OLED future a reality and that the lighting design industry needs to hammer out an answer to. These topics are:

- New applications - what lighting designers can do to maximize and diversify their business
- Seizing opportunities - what needs to be done to capitalize on the new revenue streams OLEDs promise to open up
- Performance characteristics - what benchmarks, standards and terminology OLED light designers should use to create industry wide consistency
- The collaborations and partnerships lighting designers need to cultivate to ensure long-term success

### OLEDs for Lighting Designers workshops

Our unique workshops give you the opportunity to go hands on with the OLED suppliers that you are going to need to work closely with in order to deliver incredible lighting solutions to your clients. Each workshop will enable you to drill down deep into the technological and strategic business issues you need to plan ahead for. Plus, if you haven't seen live OLED demonstrations before now, this is your chance to form a clear vision of how OLEDs will change your offerings.

**New Case Studies and sessions have already been announced - visit the summit website for the latest agenda updates**

**www.oledinsider.com**

**Check out the latest program updates! www.oledinsider.com**

OLEDINSIDER

THE WORLD'S FIRST AND ONLY OLED LIGHTING DESIGN EVENT

# OLED LIGHTING DESIGN SUMMIT 2009

DECEMBER 2-3, BOSTON, USA

Register Today & SAVE $300!

## 3 EASY STEPS TO REGISTER NOW!

## 1. Your Choice of Registration Package

Please tick the package price box you require below:

| PASS TYPE | SUPER EARLY BIRD Expires 25th Sept | EARLY BIRD Expires 30th Oct | LAST CHANCE Expires 13th Nov | STANDARD PRICE |
|---|---|---|---|---|
| **Platinum Pass:** • Full access to all conference sessions • Full access to exhibition • Attendance at all social and networking events on December 2 • Post conference online access to all audio and summit presentations • Access to all conference data | $1195 ☐ | $1295 ☐ | $1395 ☐ | $1495 ☐ |
| **Gold Pass:** • Access to all conference sessions • Full access to exhibition • Attendance at all social and networking events on December 2 | $995 ☐ | $1095 ☐ | $1195 ☐ | $1295 ☐ |
| **Association Pass:** • Available to IALD, IESNA and OLED association members only - all will be verified • Access to all conference sessions • Full access to exhibition • Attendance at all social and networking events on December 2 | $750 ☐ | $795 ☐ | $845 ☐ | $895 ☐ |

## 2. Delegate Details

Please photocopy this form for multiple registrations → Priority Code:

Mr / Mrs / Ms / Dr:

First name:

Last name:

Company: Position/Title:

Telephone: Fax:

Email:

Address:

Zip Code: Country:

OLEDINSIDER

## OLED INSIDER ISN'T JUST ABOUT SUMMITS!

Keep in touch via the website & benefit from:

- Focused newsletters
- Interviews from industry experts
- Technology updates
- Up to date reports & industry studies
- OLED Insider LinkedIn group

**Go to www.oledinsider.com to find out more!**

### Date & Venue

December 2-3, Hyatt, Harbourside, Boston, USA

### Hotel Discounts

OPV Today has negotiated a special rate for summit delegates. Full details will be sent to you upon registration

### Group Discounts

Take advantage of OLED Insider's unique group discounts. The more people you bring, the more money your company saves!

Contact the OLED Insider team on 1800 814 3459 or email register@oledinsider.com for more details

## 3. Payment

Choose one of the following payment options:

☐ I enclose a check/draft for: $ ______________

(payable to First Conferences Ltd)

☐ Please invoice my company: $ ______________

Purchase Order No.:______________________

☐ Please charge my credit card: $ ______________

☐ Amex ☐ Visa ☐ Mastercard

Credit card number:

Expiry date: Security Code:

Name on card:

Signature:

NB: FULL PAYMENT MUST BE RECEIVED BEFORE THE EVENT

### Cancellation Policy

Terms & Conditions. Places are transferable without any charge. Cancellations before November 15, 2009 incur an administrative charge of 25%. If you cancel your registration on or after November 15, 2009 we will be obliged to charge you the full fee. All credit card registrations are subject to a 5% administration fee. Please note - you must notify First Conferences (holding company of OLED Insider) in writing of a cancellation or we will be obliged to charge you the full fee. The organisers reserve the right to make changes to the programme without notice. All prices displayed are exclusive of vat unless otherwise stated but vat will be charged, where applicable, at the prevailing rate on the invoice date and the relevant details will appear on the invoice. First Conferences takes every care to ensure that prices quoted are correct at time of publishing. However, bookings will only be accepted if there is no material error in the price advertised on the website.

Designed by The No Nonsense Group: www.tnng.co.uk

**Fax this form to 1800 814 3460**

*Philips from page 9*

back to spring 2008 when the companies filed lawsuits against each other (www.ledsmagazine.com/news/5/3/7). At the core of the dispute were the patents and IP developed (separately) by LED Effects and by Color Kinetics (CK). LED Effects became part of LSG in October 2007, while CK was bought by Philips in June 2007. In its pre-CK days, Philips in North America did not have the capability to develop or make its own products, but instead teamed with smaller, specialist LED companies such as LED Effects. Using products built with LED Effects' proprietary technology, Philips was able to compete successfully against CK on various projects.

LED Effects has a long history in the LED lighting space, pre-dating by several years the formation of Color Kinetics. For this reason, LSG executives privately told *LEDs Magazine* back in 2008 that they were very confident of their position in the dispute with Philips. Several companies have previously tried to challenge the somewhat controversial patent portfolio amassed in the USA by Color Kinetics. One challenger, Super Vision, was comprehensively defeated, while another, TIR Systems, was bought by Philips and ended up on the same team as CK. With this latest announcement, we can conclude that LSG took its own dispute as far as possible and then accepted a deal that leaves the Philips/CK patent portfolio unchallenged. ◂

**MORE:** www.ledsmagazine.com/news/6/9/1

## GREEN ISSUES

### LED lamps score highly in Osram lifecycle study

Osram Opto Semiconductors has carried out a lifecycle assessment (LCA) study of LED lamps, which involved a close look at the entire life-cycle of different lamps types. The study concluded that today's LED lamps achieve similar "LCA values" to compact fluorescent lamps (CFLs) and are far superior to conventional incandescent lamps.

To evaluate lamps correctly, it is not enough just to consider energy consumption while they are in use. The relevant material and energy supplies were determined in detail for all the LED lamp's components and production processes. This involved a detailed analysis of each individual production stage; for example, the production of LED chips and lamp housings. It also included factors such as transport; for example, the transportation of an LED lamp from its production site in China to its place of installation in Europe.

For both CFLs and LED-based lamps, over 98% of the energy used is consumed to generate light, while less than two percent is allocated to production. Osram says that this has dismissed any concern that manufacturing of LED lamps might be very energy-intensive. Three independent experts are currently verifying the findings of the internal study. ◂

**MORE:** www.ledsmagazine.com/news/6/8/4

More than 4,500 white and colored LEDs provide accent, effects, and room lighting in Osram Opto Semiconductors' reception building in Regensburg, Germany. MORE: www.ledsmagazine.com/news/6/9/2

# news+views

## BUSINESS IN BRIEF

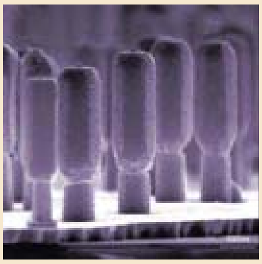
### Lumenova and Jenoptik

The two German companies have concluded a wide-ranging strategic alliance in the area of LED lighting, with the aim of achieving "a quick entry" into this "strong growth market". Applications will include public-space lighting, commercial use, and tunnel lighting. The companies will collaborate on improving Lumenova's LED light engines, as well as developing new reflector optics.

**MORE:** www.ledsmagazine.com/news/6/9/15

### GLO AB

Nanowire LED developer GLO AB, based in Lund, Sweden, has closed an SEK 82 million (approx. $11.6 million) Series B investment round. GLO employs vertically-oriented heterostructure nanowires as light-emitting diodes (see image). Bo Pedersen, CEO of GLO, said, "We are developing LEDs at levels of brightness suitable for general illumination and with efficacies equal to or better than current state-of-the-art planar chips, yet at dramatically lower cost by using readily available, low-cost and large-area silicon substrates with mass-production-friendly technologies. The Series B funding will enable GLO to complete initial product development and begin scaled transition to the pilot production stage on large-area silicon wafers.



**MORE:** www.ledsmagazine.com/news/6/9/3

### Fusion Optix

After moving to a new facility in Woburn, MA, earlier this year, the company has expanded into adjoining space, providing 60% more room for engineering, product development, and quality control. The space will house a larger, more sophisticated integrating sphere for system testing, dedicated space for LED system design, and an expanded quality control area, among other things. The added space also allows Fusion Optix to bring more capabilities in-house, such as LED array assembly and optical film coating.

**MORE:** www.ledsmagazine.com/press/19422

### Mitsubishi Chemical

The Japan-based phosphor supplier has ordered an MOCVD tool from Aixtron. This will allow the company to commence production of InGaN-based white LEDs, utilizing its own phosphors.

**MORE:** www.ledsmagazine.com/press/19773 news+views

SIGNAGE

## Holiday Inn to save with GE LED signage

More than one million feet of GE Tetra LED lighting systems will be installed across 3,200 Holiday Inn properties as part of a brand re-launch. The new exterior signage will save Holiday Inn an estimated $4.4 million annually over previous neon and fluorescent lighting ($3 million in annual maintenance savings, and $1.4 million in energy savings). This massive signage project involves more than 20 sign manufacturers creating 9,300 channel letter and box signs with GE Tetra LED lighting inside. There are more than 270 different lighting configurations across five Holiday Inn brands, where the signs range from 11 inches high to as large as 8 feet.

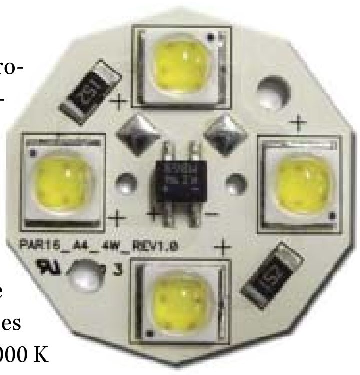

Holiday Inn expects to cut energy usage by more than half and achieve an estimated 52% reduction in kilowatt-hours with signs lit an average of 12 hours per day, 365 days per year. That represents an estimated reduction of 8,700 metric tons of $CO_2$ annually.

In related news, GE has also supplied LED lighting to support the replacement of 7,000 channel-letter signs on more than 6,500 AT&T office buildings and retail locations (www.ledsmagazine.com/news/6/7/16).◂

**MORE:** www.ledsmagazine.com/news/6/9/6

AC LEDS

## Acriche welcomes new family member




Seoul Semiconductor has introduced the Acriche 4, a new version of its alternating-current (AC) LED product, in major markets around the world. The company claims that the A4 offers "better luminous efficiency" than comparable DC-driven LEDs. The A4 devices have a color temperature of 3000 K and efficiency of 75 lm/W, while also offering a high CRI of 85. Warm-white LEDs struggle to deliver high efficiency and high CRI simultaneously. The company said, "With the mass production of the Acriche A4 series, we will be able to provide both high-quality and normal-use markets with light sources that have exceptional performance and lower prices."◂

**MORE:** www.ledsmagazine.com/news/6/8/19

# news+views

## EVENTS

### Strategies in Light Europe announced

PennWell Corporation's LED & Lighting Media Group has announced a new high-brightness LED and lighting conference and expo, Strategies in Light Europe, to be held at the Sheraton Frankfurt Hotel & Towers, Conference Center in Frankfurt, Germany, Sept. 28 and 29, 2010. The new event is the latest in the Strategies in Light series, the leading events for the global LED and lighting industry. It will join the flagship Strategies in Light event held every February in Silicon Valley, California, and the LED Japan-Strategies in Light event in Japan.

Strategies in Light Europe will focus on the LED industry supply chain, which results in products such as LED lighting fixtures (luminaires) and replacement lamps; automotive lighting; high-definition LED displays; backlighting for screens in TVs and laptops; and mobile devices, among others. Discussions will cover LED systems and end products, LED light-engines and modules and the LEDs themselves, as well as critical components such as drivers and controllers, optics, thermal management and test and measurement. Speakers will focus on issues such as critical challenges and barriers to adoption; regulatory issues and standards; government support and funding; technology updates and roadmaps; financing, and the competitive landscape.

Europe has a robust LED applications environment, ranging from automotive lighting to outdoor signage to solid-state lighting. Moreover, all elements of the HB LED vertical supply chain are represented in Europe, ranging from substrates, to process materials and chemicals, to manufacturing equipment. Robert Steele, director of optoelectronics programs for Strategies Unlimited, which launched the original Strategies in Light in 2000, said, "Europe accounted for $1.1 billion or 22% of the world HB LED market in 2008."

Strategies in Light, the leading events for the global LED and lighting industry, attracted more than 2,000 attendees at its 2008 flagship event in Santa Clara, CA, USA, and the 11th annual event will take place on Feb. 10-12, 2010. The second annual LED Japan Conference & Expo, recently held on Sept.16 -17, 2009, in Yokohama, Japan, attracted more than 5,300 participants. For contact information and more details, see the ad on page 47. ◄

## MARKETS

### Strategies Unlimited unveils new HB-LED market report

According to market research firm Strategies Unlimited in its recently released report "High-Brightness LED Market Review and Forecast – 2009," lighting and LCD backlighting are the applications that will drive market recovery in 2010 and over the next five years, with market growth forecast at a CAGR of 24%, reaching $14.9 billion in 2013.



LEDs MAGAZINE | Previous Page | Contents | Zoom in | Zoom out | Front Cover | Search Issue | Subscribe | Next Page | qMags

In all market segments, the penetration rates for the use of HB-LEDs continue to grow. The fundamental drivers for HB-LED adoption have not changed, but rather it is the impact of the worldwide economic recession on end-product demand, rather than any slowdown in the rate of HB-LED adoption, that is causing the HB-LED market to dip in 2009. For more discussion on this subject, see Bob Steele's Last Word column on page 52.

The new report is the tenth from the company on LED applications and markets. It analyzes the HB-LED market in depth, from both the demand side and the supply side, including supplier market shares. Detailed quantitative market analysis is provided, including breakouts by application and product type, in terms of units, ASPs and revenue. Five-year market forecasts are provided for each application and HB-LED product type. For more information on the report, contact Tim Carli, Sales Manager, at +1 650 941-3438 ext. 23, or by email at tcarli@strategies-u.com. ◄

**MORE:** www.ledsmagazine.com/press/19756

EVENTS

## Strategies in Light names Advisory Board members

Strategies Unlimited and PennWell Corp. have announced the members of a newly formed Advisory Board for the Strategies in Light conference, which takes place in Santa Clara, CA, Feb. 10-12, 2010. Strategies in Light (www.strategiesinlight.com), the leading event for the HB-LED and lighting industry, is the annual forum for presenting the latest innovation in the HB-LED markets, applications, products and regional activities. "We realize the contributions from Advisory Board members are critical to the continued success of our event," said Robert Steele, Conference Co-Chair. "The diversity of our Advisory Board ensures that our event will provide invaluable insight and dynamic discussions on the industry trends and technologies that are driving the global LED and lighting industry." The members are:

- Robert Steele, Conference Co-Chair and Director of Optoelectronics Program, Strategies Unlimited
- Vrinda Bhandarkar, Conference Co-Chair and Senior Market Research Analyst, Strategies Unlimited
- Derry Berrigan, Principal, DBLD Sustainable Lighting Design
- Jed Dorsheimer, Principal and Senior Analyst, Canaccord Adams
- Cary Eskow, Director, Avnet Lightspeed
- Nadarajah Narendran, Director of Research, Lighting Research Center/RPI
- Robert Walker, Principal, Sierra Ventures
- Tim Whitaker, Editor, LEDs Magazine
- Howard Yaphe, Senior VP Manufacturing and Engineering, Philips Canlyte ◄

**MORE:** www.ledsmagazine.com/news/6/9/4



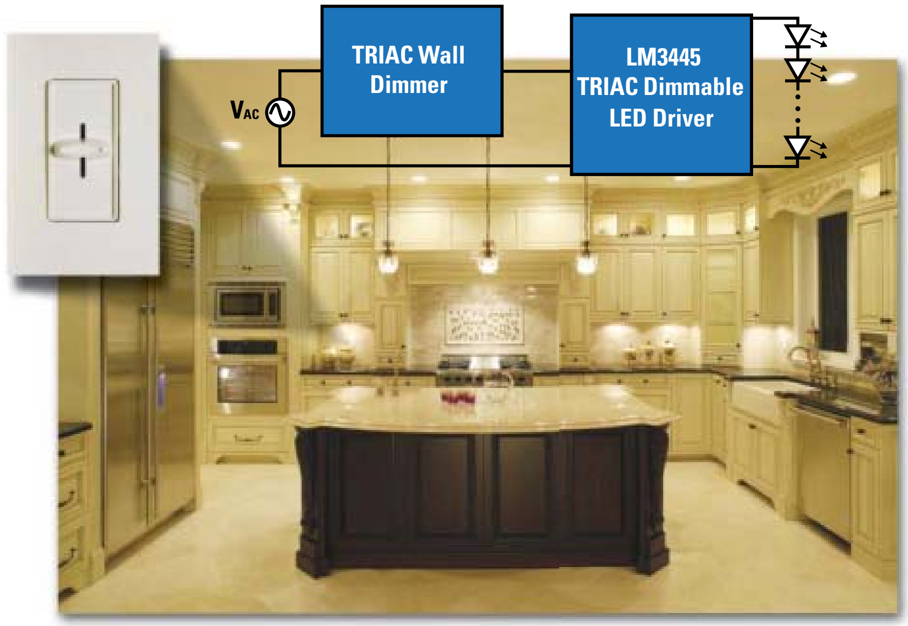
PowerWise®

# Best-in-Class Dimming Performance. High Efficiency.

## High Performance, TRIAC Dimmable LED Driver

National's industry-leading TRIAC dimmable offline LED driver solution is perfect for any application where an LED driver must interface to a standard TRIAC wall dimmer. National's new TRIAC dimmable LED driver delivers a wide, uniform dimming range free of flicker, best-in-class dimming performance, and high efficiency—all while maintaining ENERGY STAR® power factor requirements in a typical application.

✔ Online design tools
✔ Reference designs
✔ Application notes




### Full Range Dimming Capability

National's TRIAC dimmable LED driver offers 100:1 full range dimming capability, going from full light to nearly imperceptible light in a continuous range without being extinguished, and maintains a constant current to large strings of LEDs driven in series off of a standard line voltage.

### Easy To Use

National's TRIAC dimmable LED driver enables a direct replacement of incandescent or halogen lamp systems that are currently interfaced to a TRIAC dimmer without having to change the original infrastructure or sacrifice performance. In addition, the new TRIAC dimmable LED driver is available in WEBENCH® LED Designer to allow for easy and quick design in.

### Uniform Dimming Without Flicker

National's TRIAC dimmable LED driver allows master-slave operation control in multi-chip solutions which enables a single TRIAC dimmer to control multiple strings of LEDs with smooth consistent dimming, free of flicker.

national.com/led

National Semiconductor

# funding + programs

## Philips submits LED lamp to DOE for L Prize consideration

The Bright Tomorrow Lighting Prize (L Prize) competition has received its first entrant, an LED-based replacement for a 60W incandescent lamp from Philips Electronics. The US Department of Energy (DOE) launched the L Prize initiative to spur development of

**Cree LED Lighting's High Output 6-inch Downlight and Philips Color Kinetics' eW Cove Powercore were the Grand Prize winners for the SSL section of the Lighting for Tomorrow competition.**

**MORE:** www.ledsmagazine.com/news/6/9/18.

high-quality, high-efficiency LED replacements for the common light bulb.

The LED replacement for a 60W incandescent lamp must demonstrate 900-lumen output but with an energy consumption of less than 10W, equating to efficacy of more than 90 lm/W. Other requirements include a color rendering index (CRI) greater than 90, a color temperature between 2700K and 3000K, and a lifetime of more than 25,000 hours.

The Philips submission will undergo comprehensive evaluation, including performance testing conducted by independent laboratories, field assessments conducted with utilities and other partners, long-term lumen maintenance testing and stress testing under extreme conditions.

Meanwhile, the DOE said that it hopes to see more entries. Entries will be accepted in each product category until a winner is declared. The first entrant in each category to successfully meet the competition requirements will receive a substantial cash prize, and will also be considered for federal purchasing agreements, utility programs, and other incentives. DOE says 27 utilities and program partners stand ready to promote and develop markets for the winning products.

"Philips is confident that the product submitted meets or exceeds all of the criteria for the L Prize," said Rudy Provoost, CEO of Philips Lighting. "By being the first to enter this very tough competition, Philips has demonstrated its commitment once again to playing a leading global role in lighting innovation and energy conservation."

Established through the Energy Independence and Security Act of 2007, the L Prize offers substantial rewards for the first manufacturer to meet its very demanding requirements—ensuring that performance, quality, lifetime, cost and availability meet expectations for widespread adoption and mass manufacturing. The legislation challenges industry to develop replacement technologies for two of today's most widely used and inefficient technologies: 60W incandescent lamps and PAR 38 halogen lamps. It also calls for development of a 21st Century Lamp that delivers more than 150 lm/W. ◄

**MORE:** www.ledsmagazine.com/news/6/9/24

## Recent updates from DOE's SSL program

**Lighting Facts:** Philips caused a stir when its LED lamps went on sale at Home Depot, a major US retailer, carrying a Lighting Facts label to verify the lamps' performance. Unfortunately, Philips had not obtained the labels from the Lighting Facts program (run by the DOE) but had made the labels themselves. DOE was informed of the situation by a rival LED lighting maker. Philips blamed an internal procedural error and took steps to join the program and submit the required data. At the time of writing, DOE has yet to announce any action to address this loophole.

**MORE:** www.ledsmagazine.com/news/6/9/21.

**Energy Star:** a revised third draft of the Integral LED Lamp criteria has been released. Key issues include dimming, non-standard lamps, low-voltage MR16s, and reliability testing. After a third stakeholder comment period, ending October 16, 2009, DOE anticipates publication of the final criteria in early November, with an effective date of August 2010.

**Manufacturing:** The SSL Manufacturing R&D Roadmap, the end product of two stakeholder workshops sponsored by DOE in 2009, has been released. The Roadmap represents industry consensus on the expected evolution of SSL manufacturing, best practices, and opportunities for improvement and collaboration.

**Street Lighting:** To leverage the efforts of multiple cities pursuing evaluations of LED street lighting products, DOE plans to form a Municipal Solid-State Street Lighting Consortium, which will collect, analyze, and share technical information and experiences.

**MORE:** www.ledsmagazine.com/news/6/7/19.

**Gateway:** A report has been published from a demonstration of LED roadway lighting on the I-35W bridge in Minneapolis, MN. The project represents the first installation of LED lighting on a major interstate thoroughfare in the United States.

# Module development lights up the future LED value-chain

As the LED revolution causes major disruption in the lighting industry, many companies, particularly those in the LED sector, are contemplating how to position themselves for future growth and profitability. McKinsey's comprehensive research shows that current LED industry dynamics favor LED moduling, as **MICHAEL VIERTLER**, **DOMINIK WEE**, and **OLIVER VOGLER** discuss.

As in other industries that have been derailed by disruptive technology, the "LED revolution" is forcing the lighting industry to redefine itself. Many lamp and luminaire players are realigning their strategies, deciding how and when to adopt the new and innovative LED technology. LED manufacturers, who historically have been accustomed to a component business based on shipping large volumes of through-hole LEDs, are also thinking about their coverage along the value-chain and whether there are any strategic plays they can exploit by becoming more integrated or focusing on specialty lighting applications. Given that optoelectronics is one of the fastest-growing semiconductor segments, traditional semiconductor players are also looking for potential opportunities to enter the LED business.

Based on McKinsey's proprietary research on the professional lighting industry, this article discusses how the profit pool around today's traditional lighting value-chain will develop into the LED lighting value-chain of 2020, and the implications this has for companies at different steps of the value-chain. McKinsey's research shows that "moduling"—the development of LED-based modules—will be the most attractive value-chain step going forward.

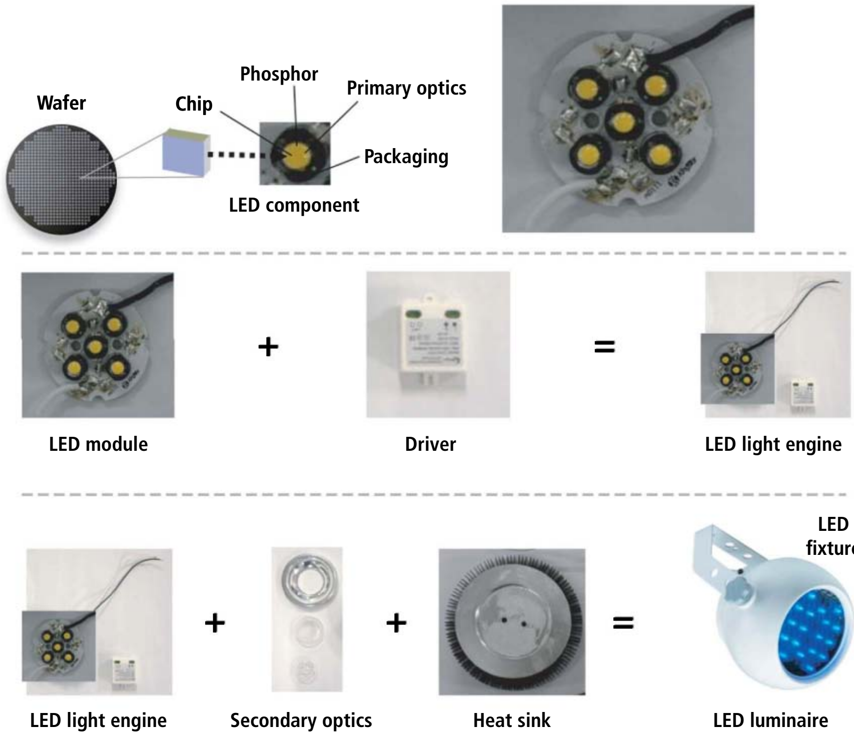



**FIGURE 1.** The LED value-chain consists of a variety of components and processes, starting with the chip and ending with the final luminaire .

### Traditional lighting value-chain today

At present, the traditional lighting value-chain consists of four major steps—lamp, ballast/optics, luminaire, controls—with the strongest industry focus on lamps. With Osram, Philips, and GE covering more than 60% of the worldwide market, there is only limited room for other players that mainly focus on specific lamp applications (e.g. Megaman for CFL). The situation in the luminaires market, which is highly fragmented but with one truly global market leader (Philips Lighting), is the complete opposite—it has around 20 international players with strong regional leadership and more than 300 small- to medium-size players that are national champions or purely local players. This fragmentation is rooted in limited economies of scale and strong product localization (design, electricity regulations, and connectors).

The global annual revenue for traditional lighting was around €40 billion in 2008. Professional luminaires account for the majority share (€25 billion), followed by lamps (€11 billion), and then ballasts and controls (€2 billion each).

MICHAEL VIERTLER *is Partner in the Munich, Germany, office at McKinsey & Company.* DOMINIK WEE *and* OLIVER VOGLER *are Consultants in the Cologne and Munich offices, respectively, and are members of the LED competence center at McKinsey.*

McKinsey estimates the current total profit pool for the entire professional lighting value-chain at around €3.5 billion worldwide. Our analysis shows that 70% of global profit goes to luminaire manufacturers because they cover the most value-add, and because there are many specialized applications and significant demand for customized fixture designs.

Profit pool development for traditional and LED lighting

| Traditional lighting share of profits | | LED lighting share of profits | | | |
|---|---|---|---|---|---|
| | Today[1] | | Today[1] | 2020[2] | Rationale for change |
| Lamp | 20% | Epi/chip[3] | 10% | Lower | · One or two big players expected to dominate<br>· Typical commoditization |
| Ballast/ optics | 5% | Packaging | 50% | Lower | · Commoditization will happen<br>· Still significant share due to white light conversion |
| Luminaire | 70% | Moduling | 25% | Higher | · Increasing technical integration needs (e.g. chip on board) |
| | | Driver/ optics | 3% | Flat | · Growingly integrated into moduling part<br>· Potential differentiation via including driver and optics in module step |
| | | Luminaire[4] | 10% | Slightly higher | · Exploding variety of applications and solutions<br>· Threat of standardization |
| External controls | 5% | External controls | 3% | Slightly higher | · Standard component<br>· However, more sophisticated controls needed |
| | **Total = €3.5 billion** | | **Total = €0.1 billion** | **Total = €1.5 billion to €2.0 billion** | |

[1] 2007, worldwide. Source: McKinsey.
[2] Includes LED applications for general illumination only. Source: Amadeus, Bloomberg, analyst reports, expert interviews, McKinsey.
[3] Margins for white high-brightness LEDs higher, but all current LED players need to have broader portfolios due to binning variation.
[4] Professional segment only.

**LED lighting value-chain today**

In the LED world, the professional lighting value-chain steps are very similar to those in traditional lighting: epi/chip, packaging, moduling/light engine, driver/optics, luminaire, and controls (see Fig. 1). Right now this industry is still in its infancy, with revenues of around €1.5 billion and a global profit pool of around €100 million.

Since color conversion is key nowadays, despite its association with high price premiums, packaging constitutes the highest proportion of the current profit pool (see table). Not only is there on average more value-add in packaging than in the epi/chip step, but manufacturing is also less capital-intensive. Moreover, we are seeing a sharp increase in proprietary IP build aiming to uncover the secrets of converting blue LEDs into broad-spectrum white light.

From a technology point of view, the ability to deliver high lm/W chips is highly attractive. However, chip manufacturers are still struggling to depreciate huge investment volumes and amortize R&D spend. Non-top-five players are not earning much money with high-power LED chips, while more and more players seem to be overcoming the critical 100 lm/W hurdle.

Moduling, which by our definition includes SMT, primary optics, and heat management, is already stronger than the luminaire part in terms of the profit pool. In absolute terms, the luminaire part will not change dramatically compared to the traditional lighting industry. As a result, the "light source" step in the LED value-chain increases significantly. This increase will also partly be brought about by new technical requirements, such as including driver electronics or heat management at the module level.

### Hypotheses and implications

Our research shows that the global LED profit pool has the potential to grow to €2 billion globally by 2020, driven by energy saving/green technology initiatives, TCO, and superior light quality. Moduling will be the winner in relative terms, while epi/chip is expected to deteriorate the most (see table). This is subject to a series of hypotheses/trends we predict will occur over the next 10 years, bringing with them substantial implications for existing players.

### EPI/CHIP

**Trends:** Over the next 10 years, chip will be the loser among the different value-chain steps. IP barriers will finally be dismantled, at least in practical terms. Players in China and other parts of the Far East are already finding ways around current patent protection. One or two major players will eventually dominate, based on typical commoditization as witnessed in the semiconductor sector. The epi process will eventually be controlled and optimized further. As wafer sizes increase, so will yield. As in the semiconductor industry, scaling up production processes will require ever-increasing investment, as seen in traditional semifab investment cycles. Furthermore, several major, manufacturing-savvy, traditional semiconductor players are already thinking about entering the LED industry, which will also drive commoditization.

**Implications:** Chip players need to drive the cost curve themselves and think about moving to low-cost locations. A strong focus on productivity and squeezing value from binning can further drive down the cost position. McKinsey LED benchmarking shows huge potential for improvement in this area. In addition, migrating further downstream can enlarge a player's individual slice of the profit pool and help secure demand for higher chip output. Finally, it is worth considering a "pure IP play," which entails outsourcing production to contract manufacturers and focusing on design and downstream integration.

### PACKAGING

**Trends:** The packaging share is also expected to shrink over time due to commoditization within the industry. Material costs *per se* are already low, but IP-related costs will also decrease sooner or later. Still, the use of phosphor coatings to convert blue into white light will secure a significant share of the profits, since color rendering and color temperature will remain key factors for the performance of white high-brightness LEDs.

**Implications:** Even if the bulk of packaging already takes place in low-cost countries, it is still essential to continue optimizing manufacturing locations. McKinsey's LED manufacturing benchmarking shows that besides the cost component, companies cannot afford to neglect skill building for operators and engineers. If the phosphor mix can be improved further and eventually patented, this would give individual players a strong competitive advantage, at least for a while.

## MODULING

**Trends:** Moduling will be the winner in the LED value-chain for professional lighting. Not only will technical integration increase (e.g. chip on board/wafer-level packaging), but the intensity and quality of light will be significantly influenced by smart moduling techniques that increase lumen output at light engine level while optimizing thermal management. Ultimately, the winning design will be based on a de-facto standard, producing a shared platform at light engine level that includes driver electronics or is built on AC LED. This can be easily mounted by luminaire OEMs without any concrete electrical engineering competence.

**Implications:** For all players offering products at module and light engine level, the key lies in creating the dominant design. There are several areas for integration of electronics and primary optics at module level, which must be mapped out to develop new IP strategies. Installing professional patent management ensures IP is enforced and utilized. Players can drive standardization based on their own dominant design to ensure a sustainable profit base.

## LUMINAIRE

**Trends:** The luminaires part will regain importance, thanks to continued optimization of heat management and an ever-widening variety of applications and solutions. However, the ongoing threat of standardization as it relates to LED modules/light engines is eradicating luminaire players' value-added potential. In view of the go-to-market structure for luminaires, which is based on long-term customer relationships and regional particularities, there are few grounds for extensive consolidation in the luminaires market.

**Implications:** Luminaire OEMs should think about further integration along the value-chain, such as upstream toward moduling/light engines (where the value is). However, this would mean building additional electrical engineering capabilities and integration solution know-how. Moreover, these OEMs could think about exploiting the variety of additional functions available with LEDs, heading downstream toward more complex controlling systems. An alternative option would be to drive "*de jure*" standardization by having officially defined light-engine platforms, which would guarantee multiple sourcing and increase price pressure in the light engine segment.

# Air temperature emerges as a crucial factor in determining lumen maintenance

Cree has gathered a large amount of data that demonstrates the importance of air temperature, along with junction temperature and drive current, in defining the lumen depreciation of LEDs. **TIM WHITAKER** reports.

LED maker Cree recently released a white paper discussing the long-term lumen maintenance of their XLamp LEDs, specifically relating to their white XR-E devices. The company has accumulated millions of hours of long-term data under various test configurations, some of which are compliant with the recently introduced LM-80 standard.

One key outcome is a clear relationship between lumen depreciation (the percentage decrease in luminous flux output over time) and the temperature of the ambient air around the lamp ($T_{AIR}$). A higher air temperature clearly results in a faster rate of lumen depreciation; in other words, a lower $L_{70}$ lifetime (see "Definitions," p. 24).

Cree describes the testing and characterizing of LED lumen maintenance as "an evolving science based on decades of work from the component semiconductor industry." The company has fully characterized the XLamp XR-E LED lamp and has developed an accurate predictive model for its long-term lumen maintenance. The key inputs are:

- LED junction temperature ($T_J$), calculated from the solder-point temperature ($T_{SP}$)
- Forward drive current ($I_F$)
- Air temperature around the lamp ($T_{AIR}$)

From these inputs, $L_{70}$ for the LED lamp can be predicted with confidence. Fig. 1 shows the predicted $L_{70}$ lifetime for devices driven at 350 mA, and clearly demonstrates the effect of $T_{AIR}$. Different curves are measured for different drive currents.

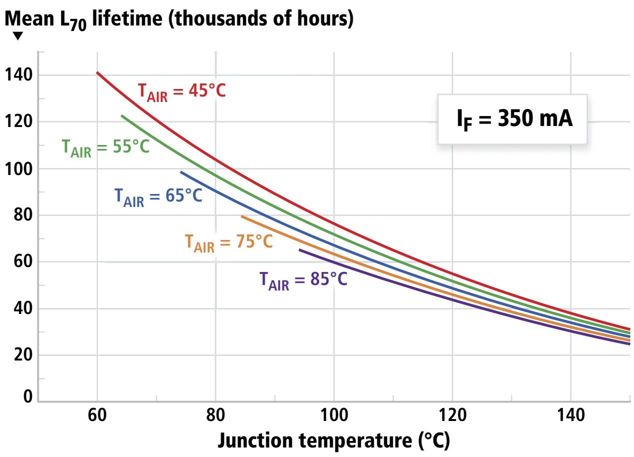



**FIGURE 1.** $L_{70}$ lifetime prediction for Cree XLamp XR-E white LEDs.

LED lumen maintenance has gained increasing attention since Lumileds first introduced "high-power" (one-watt class) LEDs in 2001. After several years of work on the subject, focusing on the effect of LED junction temperature, the Lighting Research Center and ASSIST published in 2005 the ASSIST *recommends* test procedure for lifetime testing of high-power LEDs (www.ledsmagazine.com/features/2/4/5). This procedure was revised in subsequent years and became the basis for IESNA LM-80-2008 standard, published in 2008.

Meanwhile, Lumileds published a white paper in 2007 that emphasized the importance of drive current as well as $T_J$ (www.ledsmagazine.com/news/4/4/26). Lumileds proposed a new way of presenting data that would help designers understand and evaluate the impact of temperature and drive current on lumen maintenance and failure rates of LEDs.

The latest white paper from

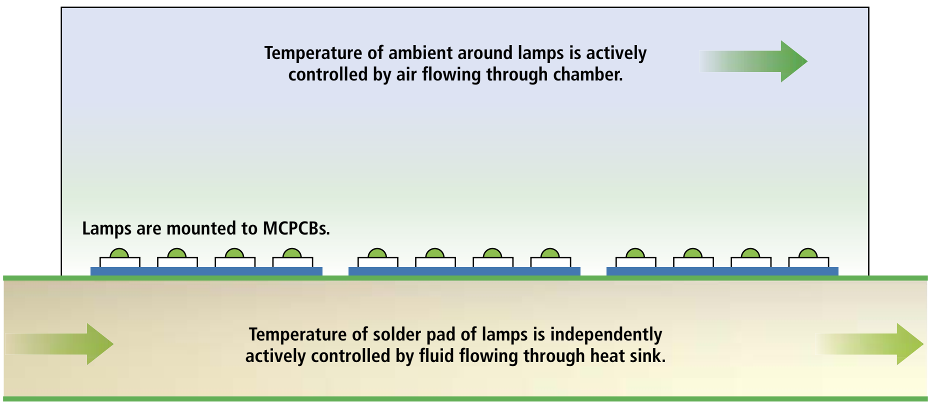



**FIGURE 2.** Configuration for lumen maintenance testing according to LM-80-2008.

Cree (see "Links") adds to the body of knowledge on LED lumen maintenance, and presents a vast amount of data that shows the influence of $T_{AIR}$. Cree was able to ensure that $T_{AIR}$ was included in the final revision of LM-80; the LM-80 testing method calls for $T_{AIR}$ in the testing chamber to be controlled within 5°C of $T_{SP}$ and for drafts to be minimized in the immediate vicinity of the devices under test.

Cree's test configuration consists of sets of 30 LEDs mounted onto metal-core PCBs, which are in turn attached to heat sinks inside environmental test chambers. The $T_{SP}$ of each LED lamp is actively monitored and controlled by continuously regulating the temperature of the heat sinks. The $T_{AIR}$ in the chamber is also actively monitored and controlled by regulating the temperature of the air flowing through the chamber. The two temperature control systems are independent from each other.

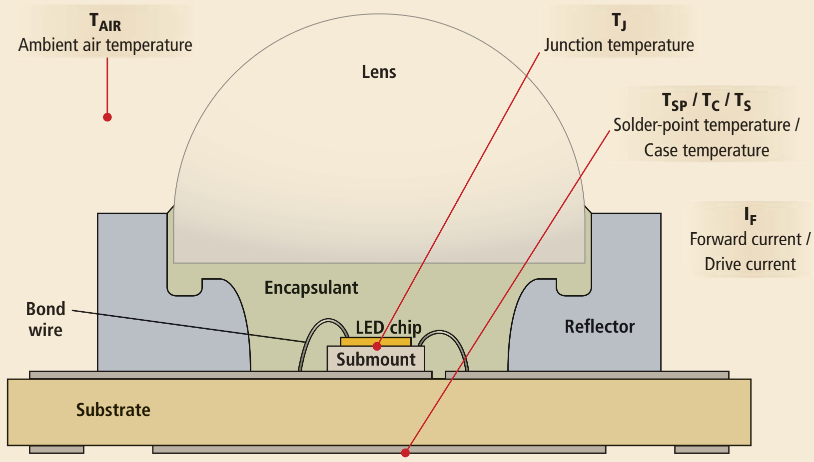
So why does air temperature affect lifetime? Cree has determined that the silicone-based encapsulants used by many LED makers degrade when exposed to high temperatures. As they degrade, the encapsulants transmit less light. The higher the air temperature, the more the encapsulant will degrade. This is a phenomenon that affects, to a greater or lesser extent, all the silicone encapsulants that have a good refractive index for efficient light extraction.

Degradation is caused by the removal of volatile compounds from the silicone material, and as such there comes a point when this process stops and lumen maintenance is dominated by chip degradation, which is a slower process. Cree has observed that, for its XR-E white XLamps, this change occurs after 5000 hours. So, the lumen maintenance characteristics are different in the first 5000 hours compared with the subsequent time period. Different Cree LEDs, and different products from other manufacturers, will all exhibit slightly different behavior.

## Definitions

**Rated Lumen Maintenance Life ($L_{xx}$):**
The elapsed operating time over which the LED light source will maintain a percentage, xx, of its initial light output. For example, $L_{70}$ = time to 70% lumen maintenance, in hours.

**Temperature, Ambient Air ($T_{AIR}$):**
The temperature of the air immediately surrounding the LED. In general, this temperature should be measured outside the FWHM beam angle of the LED and within the same enclosure that contains the LED.




**Temperature, Junction ($T_J$):**
The temperature of the junction of the LED die inside the LED lamp. Measuring the LED die temperature by direct mechanical means is difficult and may lead to erroneous results. Cree recommends measuring $T_J$ indirectly through measurement of TSP, VF, and IF and using the following equation:

$$T_J = T_{SP} + ( [R_{th\ J\text{-}SP}] \times [V_F] \times [I_F] )$$

Note: $R_{th\ J\text{-}SP}$ is the thermal resistance between the LED junction and the solder point of the LED lamp. This parameter is provided on all LED data sheets.

**Temperature, Solder Point ($T_{SP}$):**
The temperature of the thermal pad on the bottom of the LED lamp. Cree shows the recommended $T_{SP}$ for all XLamp LED lamps in each applicable Soldering & Handling document. Also called case temperature ($T_C$).

A "best fit" algorithm has been developed by Cree to accurately model the XR-E lumen maintenance behavior, based on the critical parameters $T_{AIR}$, $T_J$, $T_{SP}$, and $I_F$. This has been used to generate graphs such as Fig. 1.

The data will help designers understand the effect of, for example, building a luminaire in which the LEDs experience an elevated ambient air temperature, and should help them more accurately model the performance of their products under real conditions. As Mark McClear, Cree's director of business development, puts it, air temperature is the "third leg of the stool"—along with junction temperature and drive current—in determining lumen maintenance. Likewise, as customers ask for and expect good data, lumen maintenance is a "third leg" along with energy efficiency and cost savings that will support the case for LED lighting.

**LINKS**

**Cree XLamp Long-Term Lumen Maintenance white paper:**
www.cree.com/products/pdf/XLampXR-E_lumen_maintenance.pdf

**LED lighting standards:** www.ledsmagazine.com/features/6/6/7

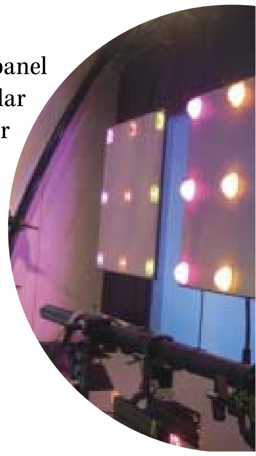
# focus on Entertainment

*PLASA, the annual trade show for the Professional Lighting and Sound Association, took place from Sept. 13 to 16 in London. As usual it provided a comprehensive showcase of recent developments in lighting for the entertainment industry, with many companies showing LED-based products. Among the eight winners of the PLASA Awards for Innovation were ETC, for its Selador LED-based product line, and Cast for its wysiwyg R24. This design and visualization software allows stage designers to simulate all manner of lighting and effects, and has recently been updated to include LED-based screens and their content. Tucked away at the back of the second hall was VER, a rental company, which had an impressive 3D LED display. The display consisted of a regular 8 mm display overlaid with a patterned optical material to create the 3D effect. Of course, the display ran special 3D content and was viewed through 3D glasses.*

The VLX Wash luminaire is the first LED-based product from Dallas, TX-based Philips Vari-Lite, and was impressive for its output of 14,000 lumens (at 840 W), and its price tag in the $10,000 range. The VLX contains seven LED light-engines, each based on an RGBW chipset from Luminus. The 120 W chipsets are replaceable. Light is mixed within a long optical system that resembles a champagne glass, to ensure smooth color mixing. There is a substantial cooling system at the base of the luminaire, but operation is extremely quiet. White light can be produced between 3000 K and 9000 K. Fixtures are factory-calibrated for color consistency.

eldoLED, a driver manufacturer based in Eindhoven, the Netherlands, showcased a number of products at PLASA (see www.ledsmagazine.com/press/19749), including several 4-channel, DMX/DALI/0-10V-compatible constant-current and constant-voltage LED drivers/controllers. Meanwhile, a 12V AC LED driver/controller was aimed at halogen-lamp replacement and has typical efficiencies of 85% (12V AC) and 92% (12V DC). Power factor is 0.8, and flicker-free dimming is possible down to 0.5%. The photo shows PowerPix 530 modules, a string of 30 high-power (5W) RGBW pixels for dynamic color applications. The pixels are individually controllable over DMX and have a flexible pitch, as they can be positioned anywhere along the cable.

The LedCyc9*RGBW panel from LDDE is a modular backlight system for rear-projection onto cyclorama material and other projection surfaces.



SkyLine outdoor architectural floodlights from PixelRange, contain multiple Luxeon K2 LEDs.

▲ The distinctive hexagonal form of the i-Pix BB7, which combines seven 10-degree homogenized RGB beams.

▲ The MAC 401 Dual from Martin is a LED-based moving head washlight with a beam-reflective mirror on the rear.

AC Lighting previewed ▶ the Color-Q Color Charge, a battery-powered LED fixture that also allows wireless control and syncing between units. The 12 LEDs produce 600 lumens in total, in RGBA, with adjustable CCT and CRI of 92.

▲ The Tracker 300 from Showtec contains 9 LEDs that can be driven at 1400 mA (6W). Each LED can operate independently. The beam angle is 5 degrees, and the luminaire can produce 18,200 lux at a distance of 1 m.

In early 2009, ETC acquired Selador and its LED-based product line of fixtures, which are based around the x7 Color System. Specifically designed for the requirements of theater lighting, this fixture combines seven LED colors into a single luminaire, broadening the spectral range and creating a "nearly limitless palette" that gives "natural color to people and objects." Different models use either Luxeon K2 or Rebel LEDs and have different lenses and arrangements of LEDs, depending on the specific application (stage washes, long throws, scenery lighting). ▶

software | **OPTICAL DESIGN**

# LED attributes for accurate modeling: An optical designer's wish list

LED manufacturers provide much information in data sheets and ray data sets, but additional information about their products would help designers model their systems more accurately, says **PATRICK LE HOUILLIER** and **MIKE ZOLLERS.**

When using software to design an optical system with LEDs, many LED characteristics must be considered to allow them to be modeled accurately. Manufacturers provide much of this information in their datasheets. Additionally, many manufacturers provide measured data in the form of ray data sets for their products. As designers, we laud the industry for this increased openness, but there is room to improve the level of detail provided by manufacturers to optical designers. We examine four such LED details that may need to be modeled in an optical design, explain why and under what conditions these details are necessary, and propose ways to supply the requisite data. This is not a comprehensive list of details needed for every LED design, but a subset of significant information barriers that designers have faced over the years.

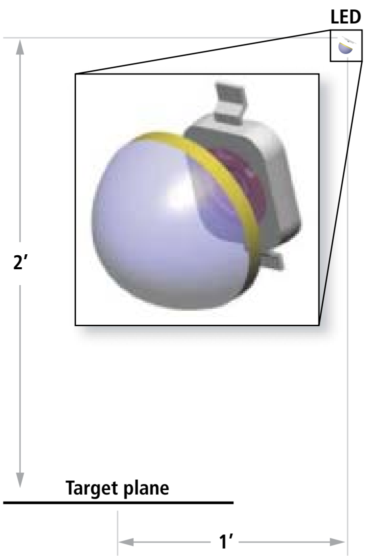



**FIGURE 1.** A simple task light can often be accurately modeled without taking the near-field light distribution into account.

### Attribute 1: Near-field light distribution

One detail that is consistently omitted when modeling LED systems is the accurate representation of the LED's near-field light distribution (for example, at a distances less than roughly 10 times the size of the source). Of course, some optical designs, such as task lighting, can be accurately modeled without taking the near-field light distribution into account. A task light is often simply an LED shining onto a flat surface. There are no obstructions between the source and its distant target; therefore, the near-field light distribution need not be considered for this scenario. However, if a lens is placed in front of the LED that focuses the die onto the same surface, the near-field light distribution must be considered. The spatial variation of the source emittance due to die masks, wires, phosphors, etc. is all imaged onto the target.

In many cases, the LED package itself increases the need for an accurate near-field model. Phosphor materials, diffuse white plastic packages, and multiple dies per package can all increase the apparent size of the emitter. Usually, the apparent size of the light emission is spatially non-uniform and dependent upon the viewing angle. Another aspect to consider is color, especially in phosphor systems. Depending on the method used to apply the phosphor to the die or its encapsulant, the length of the path that light takes through the phosphor may not be constant. Because of this, the color of the light leaving the phosphor is not necessarily the same from all viewing angles. If the optical components are near the package, or if they image the LED, accurate near-field modeling of the source and its apparent size is required.

Unfortunately, it is not always easy to tell whether the near-field distribution is important. To be sure that the design is accurate, you could always model the near-field light distribution, but the costs and limitations associated with this approach make it impractical. There are two primary methods to model the near-field light distribution: using a ray data set and using a complete geometric model.

Ray data sets represent the near- and far-field light distribution and are typically generated based upon a series of measurements that capture the spatial and angular distributions. Many LED manufacturers now provide ray data sets for their LEDs; however, they are not without their limitations. First, ray data sets are large, external files that can be hundreds of megabytes for a large number of rays, and you need to keep both the software file and the ray data set in order to reproduce your results in the future. Next,

PATRICK LE HOUILLIER *(patrick@opticalres.com) is a* LightTools *Application Engineer and* MIKE ZOLLERS *(mikez@opticalres.com) is a Senior Optical Engineer for Optical Research Associates, developer of* CODE V® *and* LightTools® *optical design software and provider of optical engineering services* (www.opticalres.com).

the ray data only models the LED's light output; there is no physical body associated with the ray data. If your optical system passes light back through the LED package (usually the dome), the effect of the geometry will not properly be modeled. Finally, ray data sets are an accurate representation of a single, measured LED. How representative of the entire production of LEDs is the single, measured LED, and consequently its ray data set? If the LED that was measured had a defect, the results of any ray trace using the data would be questionable.

Another method for representing LEDs in software is a geometric model of the LED. In this case, every element, including its optical properties, is modeled, from the die outward. This method overcomes most, if not all, of the problems associated with ray data sets. Rays are generated on-the-fly from the die, so no external storage of ray data is required, the optical effects of the geometry are always modeled, and manufacturing variability can be modeled by displacing or deforming package components. However, no manufacturers currently provide the entire die and package geometry for their LEDs. To get this data, a designer would typically have to dismantle an LED to measure its internal components, which is both time consuming and costly. Because it generates rays on-the-fly, this method also causes longer simulation times when compared with the ray data set method. Detailed geometry supplied by the manufacturer would reduce the overhead associated with creating a model.

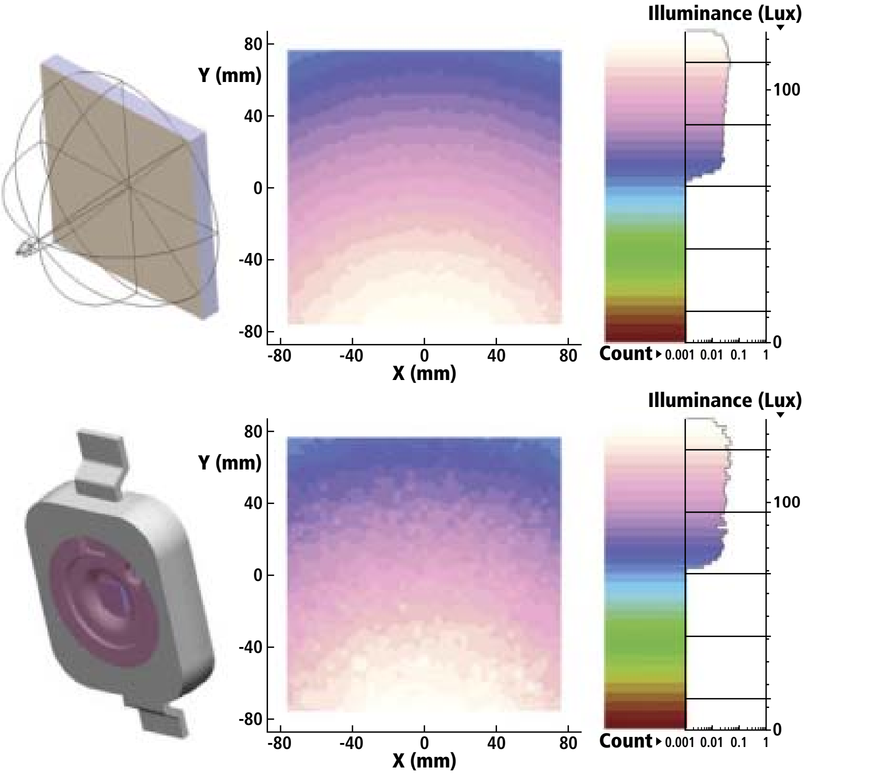



**FIGURE 2.** The task-light illuminance is shown from a simple (top) and complex (bottom) source model. There are no near-field obstructions; the simple source model is accurate for this scenario.

### Attribute 2: Manufacturing variability

LEDs are binned by output power (on-axis intensity or total flux) and color. While this level of detail is useful for some optical systems, much more information about the LED's variability is often needed.

Consider an application that images the die into the far field: an LED flashlight. The placement of the die is paramount to the performance of the design. As engineers, we would like to tolerance the system before production. We know the tolerances on the placement of the LED. The robot used during manufacturing has its tolerances, and the tolerances for the LED package are typically given on the manufacturer's datasheet. The tolerances on the imaging system are known from its manufacturer. (Very few imaging systems go into production without a sensitivity analysis.) But what are the LED's die tolerances? The LED can be accurately and repeatedly placed with respect to the optic, but if the die is shifted inside the package or is not concentric with the dome, the image of the die will shift.

An automotive headlamp also requires tight tolerances. Designers have tried for a long time, ever since white LEDs started producing real flux, to create an LED headlamp. Most of these systems, including those going into production, are refractive and image the die onto the roadway surface. In the automotive industry, the far-field intensity distribution of the headlamp is tightly regulated to prevent headlights from blinding oncoming drivers while providing adequate illumination of the roadway and overhead signs to keep drivers from hitting something. Imagine the effect of a die shift in this system. It might blind or significantly increase the glare of oncoming drivers, or it might create dark areas on the road that prevent a driver from seeing a pothole or another obstacle.

For accurate modeling of an LED's manufacturing variability, designers need two things: geometric details about the internal structures of the LED and nominal tolerances on critical dimensions. The geometry needs to be provided for the entire LED, not just the exterior. Even a drawing would be sufficient. The most critical tolerances that need to be known are the die size (in three dimensions) and its position relative to an exterior mounting point. If there is a dome, the tolerances on its position and shape are important as well.

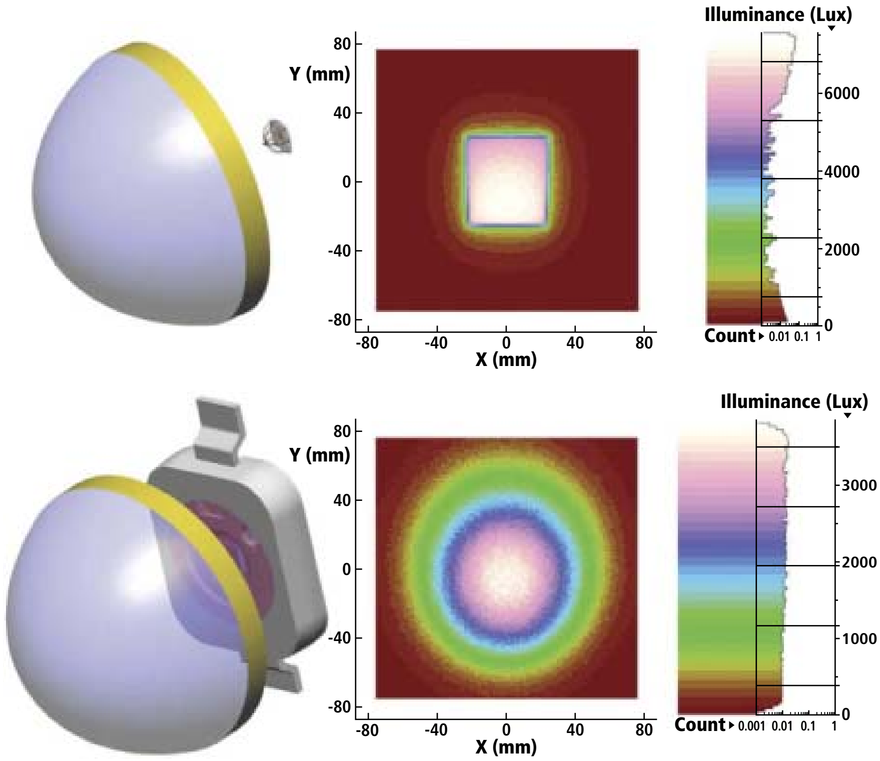
### Attribute 3: Optical properties of LED components

To accurately model any optical system in software, designers need to know the optical properties of the components, but this information is not available, even after more than ten years of modeling LEDs in software. Therefore, when designers build detailed models, they are forced to make assumptions about the properties of the plastics used in the dome and the encapsulants around the die. This is not ideal.

For the materials surrounding the die—the encapsulant and the dome (if applicable)—it is important to know:

- The index of refraction, as a function of wavelength
- The material absorption, as transmittance vs. length or an absorption coefficient
- The properties of the bulk scattering particles (for diffuse LEDs)
- The scattering profile
- The particle size and density
- The properties of the phosphor (if applicable)

**FIGURE 3.** The task-light illuminance is shown from a simple (top) and complex (bottom) source model with lenses. The lens perfectly images the simple source, but the diffuse package and the phosphor enlarge the apparent size of the source, making the complex source a more accurate representation.




- The absorption, excitation, and emission spectra
- The quantum efficiency
- The variance of the emission due to changes in excitation wavelength
- The phosphor delivery method (i.e., conformal coating, remote, glob, or embedded throughout the encapsulant)

The surface properties are a little easier to postulate. For white packages, the scattering profile is mostly Lambertian. The metallic parts in the LED package, such as the bond wires, are near-specular scatterers. However, for all of these components, the reflectivity is unknown.

The LED package is a major contributor to the spatial and angular nonuniformity of the near-field light distribution. All of these details could be specified in a datasheet or application note.

### Attribute 4: Sensitivity to external influences

This category represents a very important detail that is handled differently by every LED manufacturer. The significant external influence is heat, both ambient heat and the heat produced by the LED. Because the electrical and optical properties of the LED change as a function of junction temperature, all manufactures try to provide information about those changes. However, there is no consistent set of information provided on a datasheet.

First, let's look at the electrical considerations. Some manufacturers provide voltage as a function of temperature; other manufactures show forward current vs. temperature. The type of temperature provided can be either the ambient temperature (assuming a particular thermal resistivity) or the junction temperature. These create no fewer than four possible permutations of electrical degradation with temperature. Also, if a manufacturer provides ambient temperature curves, it is important to know how long the LEDs were running for that measurement. The junction temperature is very different from the ambient temperature after a short operating time.

The optical considerations are also varied in the datasheets. As the temperature increases, several things happen. First, the light output decreases. Is this due to a decrease in the forward current, or are other mechanisms at work? If the light output decreases with the forward current, then we can use the flux vs. current curves; otherwise, we need flux vs. temperature. Second, the color of the LED shifts with temperature. For a monochromatic LED, does temperature shift the peak wavelength of the emission, or does it broaden the spectral half-width? Does it shift both? What about phosphors? The blue LED's color is shifted due to the temperature variation, but so is the phosphor. How does it change? If we're modeling the phosphor as excitation and emission spectra with internal quantum efficiency, what do we change? Many datasheets provide light output vs. temperature. Some datasheets provide CIE chromaticity vs. temperature.

All of these details are important, and they need to be presented consistently by all manufacturers. Heat is by and large the most important nonoptical consideration for designers. Determining an acceptable loss of system performance due to heat can drastically change the cost of the system, from reducing the size of the heat sink to potentially driving the need for an active feedback loop to control color.

### Concluding remarks

Many systems designed with LEDs are destined to enter the consumer market, and while some consumers may purchase an LED product based solely upon its uniqueness, novelty, or its power savings, in order for a design to garner significant consumer acceptance, it needs to be cost-effective, purposeful, and aesthetically pleasing when illuminated.

Consider again the LED flashlight. To compete against low-cost filament flashlights, one common design goal for an LED flashlight is a very bright, uniform light distribution. When a single LED is used, the optics are invariably placed in the near-field region, and designers go to great lengths to make their optics intolerant to the near-field and manufacturing variations. Otherwise, the flashlight's output has the potential for nonuniformity and significant part-to-part variation. For these systems, a good model of the near-field light distribution and LED manufacturing tolerances are needed.

Designers seek to improve designs in ways that are possible only with the influx of additional information, while manufacturers seek to protect information because it is patented or considered a "trade secret." Perhaps the benefits of the former outweigh the cost of the latter. Hopefully, there is a mutually beneficial solution to this age-old problem.

# Direct or Indirect: That is the question for optical configurations

For optical designs, the choice of direct or indirect configuration is determined by a number of competing factors and by considering the priorities of the lighting solution, writes **ANDREAS BIELAWNY**.

The LED, the solid-state light source of the future, differs in many aspects from every other classical light source. For now, let us consider only one aspect: LEDs are surface emitters, and because of the planar substrates on which they are currently deposited, the die generally exhibits a half-space emission characteristic.

Therefore, all LED applications can generally be divided into two groups: direct and indirect (see Fig. 1). The terms *direct* and *indirect* describe the relation between the LED and its secondary optic components, or the light target (the main optical axis). Also, the term *direct* (as for *direct light/flux*) is also used to emphasize the fact that LED applications use the flux from the primary optic lens of the emitter to create the light distribution.

**Direct:** A direct optical configuration is characterized by the alignment of the optical axis of the emitter(s) with the main optical axis of the light. This need not necessarily be coaxial. It can also be considered an issue of the direct visibility of the emitter (from a point of view within the desired angular emission range of the light). A descriptive example is a projector application using aspherical lenses for image creation. Such arrangements would be addressed as direct type, but they strongly restrict the visibility angles of the emitter, which is observed only through secondary optics.

**Indirect:** In contrast to the direct configuration, an indirect optical configuration will always prevent the emitter from being observed directly. Instead, the flow of light will be controlled completely by secondary optics, such as free-form reflectors. In the archetypical representation of an indirect configuration, the optical axis of the emitter will be anti-parallel to the optical axis of the light (the reflector); for example, a perfectly reverse orientation. Any semi-direct solutions are also possible.

This distinction is mainly relevant to reflector applications. In general, TIR collimator optics, projector systems, and refractive systems tend to make use of the direct orientation and there are only a few reasonable occasions when a design with indirect emitter orientation is useful. Mostly, designers do not decide between the direct or indirect orientations, but instead the decision is for or against a certain design option, as there are limitations to the deliberate use of either configuration type.

## Making the choice

The choice of a direct or an indirect approach cannot be made instantly in many cases. If possible, we should first take a step back to the simple question: "What is the principle nature of this application?" Of course, there are a multitude of possible answers, for example wall washer, ambient lighting, or street light.

A brief analysis of the intended application can help with the decision on the fundamental design options of direct or indirect:

- Are there specifications or restrictions to the type of LED?
- What are the specifications on the dimensions and geometry?
- What measure of light control is required?
- Is direct emitter flux helpful/acceptable/to be restricted?
- Will the light be directly visible to the human eye? How? And is this intended?

ANDREAS BIELAWNY *(bielawny@brandenburg-gmbh.de) is an Optical Engineer with Brandenburg GmbH (www.brandenburg-gmbh.de), Paderborn, Germany.*

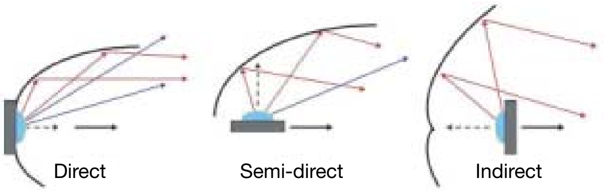



**FIGURE 1.** LED and reflector design options include direct, semi-direct, and indirect arrangements. Short arrows mark the optical axes of the emitter (dashed) and the complete light source (solid).

## LED specifications

Although a huge variety of high-flux LEDs is available, two common aspects are of high importance for consideration when it comes to the choice of direct or indirect arrangement. The first one is the primary optics type. It is

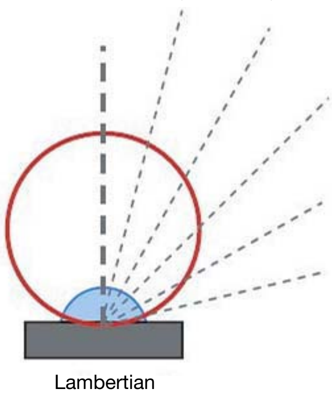



**FIGURE 2.** A Lambertian distribution emits 50% of the complete flux into the forward cone of 30° half angle (NA of 0.5).



LEDs MAGAZINE | Previous Page | Contents | Zoom in | Zoom out | Front Cover | Search Issue | Subscribe | Next Page | qMags

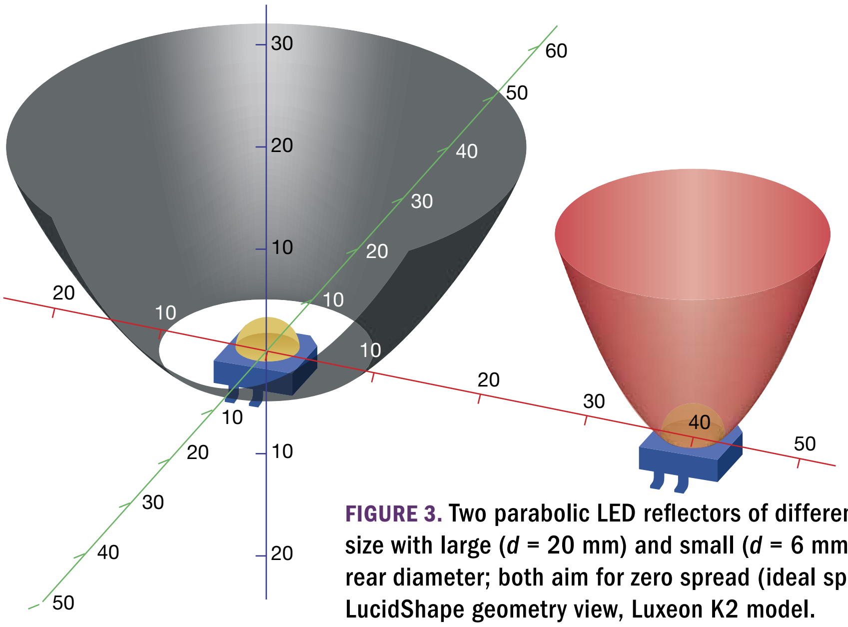


FIGURE 3. Two parabolic LED reflectors of different size with large (*d* = 20 mm) and small (*d* = 6 mm) rear diameter; both aim for zero spread (ideal spot); LucidShape geometry view, Luxeon K2 model.

important to take a look at the impact of primary optics and the resulting emission characteristic of an LED. A Lambertian distribution emits 50% of the complete flux into the forward cone of 30° half angle (NA of 0.5). Consequently, a reflector (direct setup) that leaves an aperture of 30° half angle would effectively control only half of the luminous flux. With a side-emitting LED, the result is different.

The exact distribution should be considered; even the small deviations between the different representations of so-called Lambertian emitters can make a difference when it comes to obtaining satisfying light patterns.

The second aspect is the size of the LED. A smaller die gives an advantage for enhanced light control and imaging quality because absolutely smaller images are possible. In this case, the higher the source luminance, the closer the LED will perform to a point source. The trade-off, that extremely bright LEDs are also sources of intense glare, is in some applications a major drawback. Many architectural lighting problems and especially street lighting favor or require a limited source luminance.

Conversely, high-flux LEDs of low source luminance are not well suited for point-source applications. They are mostly multi-die LEDs and make use of chip-on-board techniques, enlarged common phosphors, or similar technological approaches. But due to their lower luminance, such LEDs are the better choice for direct arrangements if emitter visibility cannot be avoided. Especially for urban and interior lighting, these emitters can perform particularly well.

In optical-development software such as LucidShape, the modeling of solid-state emitters, or the use of manufacturer's LED ray-files, allows for a quick estimation as well as for a thorough analysis of different emitters, to assist in selecting the best-suited type for a certain task.

## Dimensions

The specified dimensions for a lighting concept can narrow down the design options available to the light engineer. Thus, they

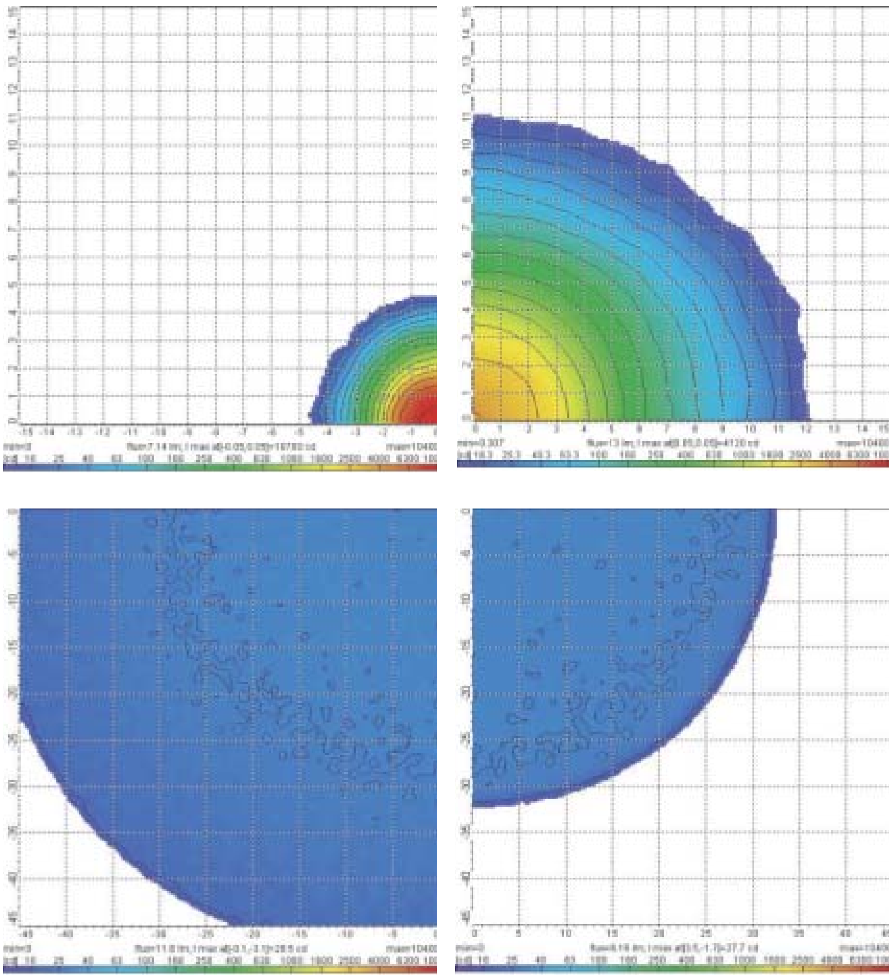


FIGURE 4. Candela distributions: quadrants of LucidShape UVData views from large (left) and small reflector (right) simulation results. Indirect flux from the reflector only (top) with an angular range of ±15° and direct flux from the emitter (bottom), ranged ±45°. Axes are scaled in degrees of angle, intensity is of iso-scale in logarithmic false-color coding.

ILLUMINATION DESIGN SOFTWARE

# Optimize With LightTools

## *Design, Analyze, Optimize and Deliver*

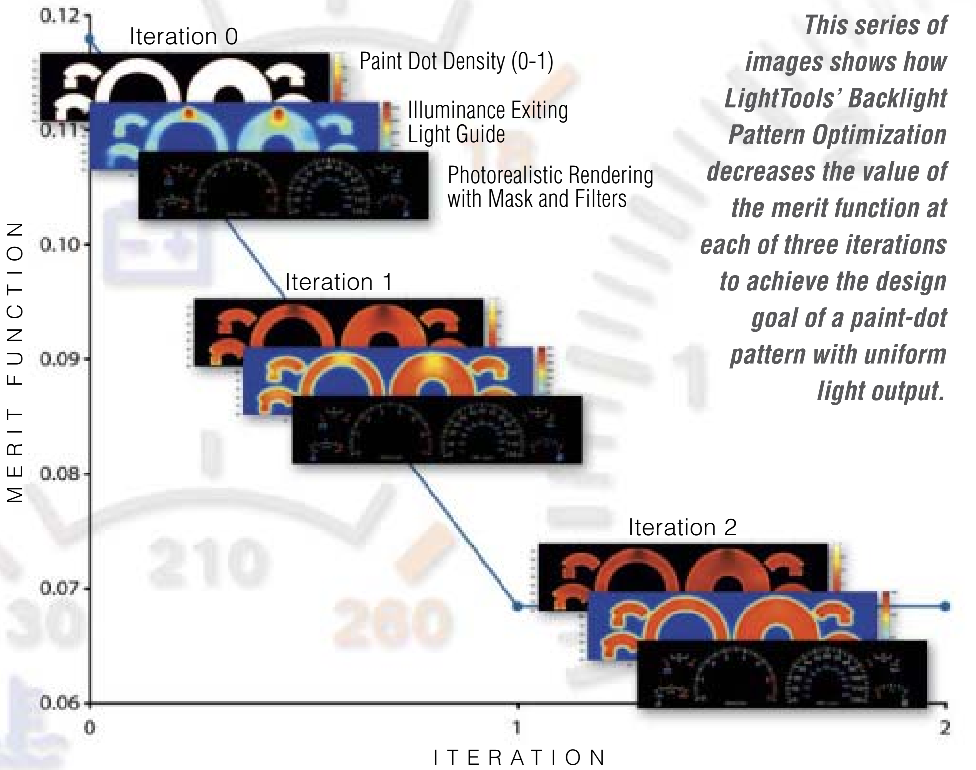
Model any illumination system with *LightTools'* powerful design, analysis, and optimization features.

**Design**
Interactive point-and-shoot ray tracing, extensive libraries of optical elements, seamless information sharing with CAD programs, and modeling of real-world optical effects—such as polarization, scattering, and color filter performance—are just a few of *LightTools'* comprehensive design features.

**Analyze**
*LightTools'* fast, reliable Monte Carlo ray tracing and full suite of simulation tools help you explore design alternatives, study light behavior, and identify and fix potential problem areas early in the product development process.

**Optimize**
*LightTools'* fully integrated illumination optimization capability automatically creates the best design within the design space. New features meet evolving industry needs.

**Deliver**
Deliver illumination systems that meet project specifications and schedules every time.




*This series of images shows how LightTools' Backlight Pattern Optimization decreases the value of the merit function at each of three iterations to achieve the design goal of a paint-dot pattern with uniform light output.*


*Final Result : Iteration 2*

**New Optimization Features**

- **Backlight Pattern Optimization** for automatic design of backlight extraction patterns for LCDs, cell phone key pads, and automotive instrument clusters.
- **Parameter Sensitivity** analysis for selecting the best set of variables prior to system optimization.
- The **SolidWorks® Link Module** for dynamic linking of SolidWorks models to *LightTools*, where you can optimize optical elements, parts, and assemblies.

LightTools®
www.opticalres.com

OPTICAL RESEARCH ASSOCIATES

***Corporate Headquarters:*** 3280 East Foothill Boulevard, Pasadena, CA 91107-3103 (626) 795-9101
Fax (626) 795-0184 E-mail: info@opticalres.com Web: www.opticalres.com
***Offices:*** Tucson, AZ | Westborough, MA

can imply the use of a certain direct or indirect setup or allow the freedom of choice. This is technically a trivial aspect, but nevertheless one that is of strong impact. It is not uncommon to have the exterior dimensions specified before optical developers can lay their hands on the design of a light source. Indirect setups will, in almost any case, require a greater mechanical depth as well as the need to mount the emitters off-axis or even within the optical path (reverse orientation). Direct arrangements are suited much better for limited installation sizes.

### Light control

The common primary optic of LEDs is the Lambertian type. Controlling its flux is a matter of first capturing as much flux as possible in the secondary optics, and then creating appropriately sized emitter images. Direct arrangements that produce small emitter images are usually rather large, which counteracts the first point: a consequently larger aperture allows more light to escape directly, thus reducing the reflector illumination. Large-size indirect arrangements provide the highest light control. In lighting design, the knowledge of the actual angular distribution of the LED is important if good light control is in demand. These aspects comprise a significant share of the complexity of a lighting task.

### Using direct emitter flux

The question whether direct flux from the LED should be used is specifically focused on the desired light distribution: can the emission characteristic of the LED contribute in a useful way to the intended lighting design? If that is the case, direct emitter flux enhances the efficiency of the light, since no further reflection losses occur. A purely primary optics-based design without any secondary optical components can also be more cost-effective. An approach toward enhanced light control with direct emitter flux is the application of small lenses that are directly mounted (preferably glued and optically matched) to the LED and serve simply as an extension of the primary optic. Such free-form lenses could alter the light distribution so that for certain problems, no further optics will be required. However, this is not part of the reflector-related direct or indirect discussion.

### Example: light control (paraboloid reflector)

As an example for the interplay between dimensions, light control and direct emitter flux, we compare two direct reflector setups shown in Fig. 3 in a brief virtual experiment, using the optical design software LucidShape.

Both reflectors (R = 85%) are 20 mm in depth and aim at a zero-spread spotlight. They differ by their diameter. The large reflector has a 20 mm rear diameter, the small one only 6 mm. The front apertures are 46 mm and 25 mm, respectively. Both are equipped with a cool-white *Luxeon K2 with TFFC* rayfile source, emitting about 85 lm

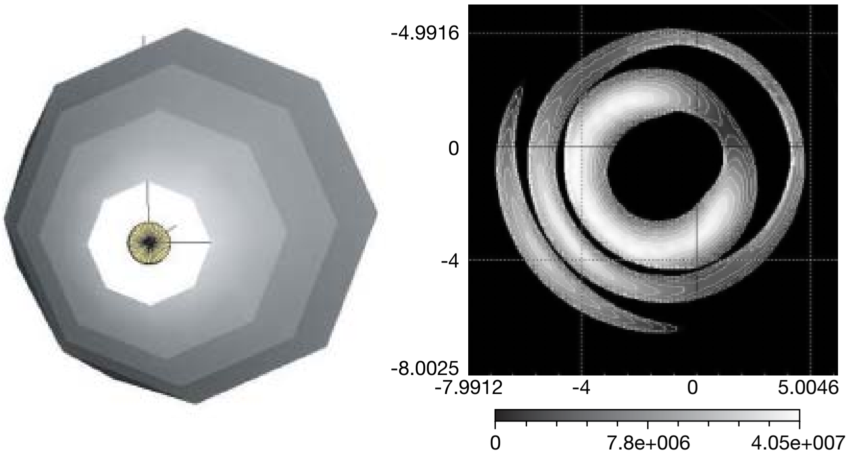
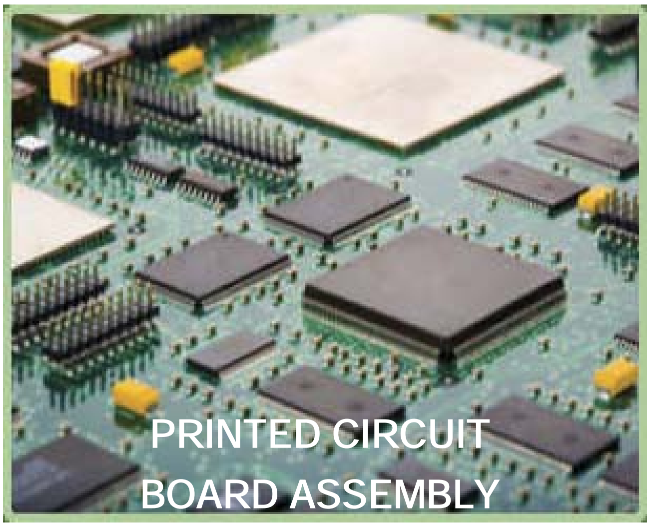



**FIGURE 5.** For an LED (direct) PS reflector arrangement with ±10° of spread, a geometrical sketch of the component shows the three profiles (left); LucidShape luminance camera sensor results from the same point of view show how the impression from the lit reflector profiles will present to the off-axis observer, at a chosen sensor resolution of 640 × 480 (right).

of flux. One of the nice things about optical simulations is the multitude of methods and tools for analysis. When we distinguish between emitter flux and reflected light, as it was done to obtain the candela distributions of Fig. 4, the impact of the light control (spotlight) becomes obvious. The top images show the reflector-controlled light. The bottom images show directly spilled emitter flux which produces a homogeneous background, with its angular size being defined by the aperture.

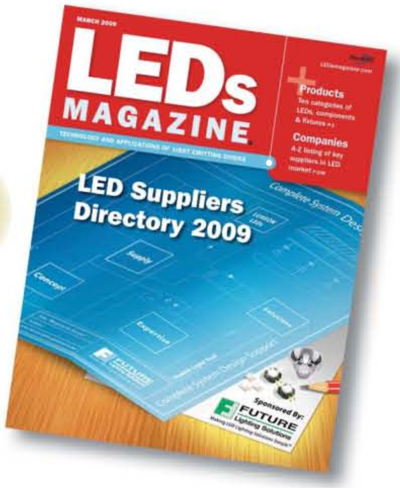
The direct and uncontrolled flux from the large reflector's LED measures about 50 lm, only 35 lm being imaged by the reflector into infinity. The reflector controls not even half of the flux from our K2. The ratio of controlled versus spilled flux can be considered a measure of light control. In contrast, the small paraboloid allows only 25 lm of direct flux due to its smaller aperture: it controls a larger share of the LED's flux. The emitter images produced by the two components strongly differ in angular size, which leads to different grades of light control, i.e. in this simple case to a difference in focusing power. The large reflector achieves about 10,000 cd at 41% flux control, the smaller one only 4000 cd, although it is controlling 70% of the flux. These basic relations yield also in more sophisticated components, such as procedural surface (PS) reflectors, which





# LEDs MAGAZINE

**Distribution Date: March 2010**
**Ad Close: 2/1/10**
**Mat'l Due: 2/8/10**




# Suppliers Directory 2010

## Integrated Advertising 24/7, 365 Days a Year!

Keep Your Message in Front of *LEDs Magazine*'s Decision Makers for a Full 12 Months:

- Recognized as an invaluable reference manual
- Delivered to 31,506* global buying professionals as the March 2010 issue of *LEDs Magazine*
- Company Directory includes an A-Z listing of more than 900 key suppliers in the LED industry
- Extensive coverage of 10 major product sections, including LED Packages & Chips, Networks & Distributors, LED Displays & Signs, Test & Measurement, LED Lighting and more
- Detailed company contact and product data for hundreds of organizations
- Bonus distribution at major LEDs and lighting events and conferences throughout 2010

The ***LEDs Magazine*** **Suppliers Directory 2010** is a comprehensive product guide and vendor directory reaching buyers of LED components and lighting and display products. Advertisers who take advantage of our Suppliers Directory integrated print and online advertising will reach key decision-makers with their product messaging.

## DISPLAY ADVERTISING

As an advertiser, you'll receive:

- **FREE** company directory listing - both print and online
- **FREE** unlimited product guide listings.
- **FREE** listing cross references to your ad page.
- **FREE** bold entries for each of your listings.

## DIRECTORY ENHANCEMENT OPTIONS

**Contact your sales representative to learn more about the following listing enhancements and advertising upgrades!**

### Enhanced Listing

- Logo and 75 words of text in Company Directory section
- Logo alongside company name in all Product Guide sections

### Priority Listing

- All enhanced listing benefits above
- Entry in Company Directory section is highlighted in a shaded box
- In Product Guide listing, logo is highlighted in a shaded box
- In Selection Charts, the Priority Entries are highlighted
- Priority Entries listed on page 1 of the Directory and highlighted in the online Buyer's Guide

**Enchancement Ad Close Date: February 1, 2010**
**Material Due Date: February 8, 2010**

**Book Your Ad Early & (Nov. 30, 2009) Lock in '09 Rates!**

DISPLAY ADVERTISING

## RATES AND SPECIFICATION

| RATES: | USD 2009 | USD 2010 | | USD 2009 | USD 2010 |
|---|---|---|---|---|---|
| Enhanced Entry | $ 685 | 935 | Full page profile or ad | $ 4180 | 4598 |
| Priority Entry | $ 1315 | 1565 | 1/2 page ad | $ 2510 | 2761 |
| Two page profile or ad | $ 7300 | 8030 | 1/3 page ad | $ 2050 | 2255 |
| | | | 1/4 page ad | $ 1670 | 1837 |

*Publisher's Own Data

**QUESTIONS: Please contact one our sales representatives for assistance.**

| USA | EUROPE | JAPAN | CHINA/HONG KONG | TAIWAN | TAIWAN |
|---|---|---|---|---|---|
| **Mary Donnelly** | **Joanna Hook** | **Manami Konishi** | **Mark Mak** | **Alice Chen** | **Vicky Kung** |
| Tel: +1 603 891 9398 | Tel: +44(0)117 946 7262 | Tel: +81 03 3219 3641 | Tel: +852 2838 6298 | *Sales Manager* | *Sales Manager* |
| maryd@pennwell.com | joannah@pennwell.com | konishi-manami@ics-inc.co.jp | markm@actintl.com.hk | alice@arco.com.tw | vicky@arco.com.tw |

www.ledsmagazine.com

PennWell®

give us control over the light spread from individual sections.

### Visibility of the emitter

Let us consider a very descriptive example of an LED application: an artificial starry sky in the ceiling of a child's bedroom. The main purpose here is the visual impression of the LEDs, while glare is not an issue as long as low-power LEDs are used. Dozens or hundreds of emitters are just there to be seen, perhaps also to be distinguished—just like any signaling application. This decorative lighting yields no significant illumination purpose, besides providing a low ambient luminance.

In contrast to this, a billboard lighting application does not even have to expose its luminaires to the human eye, as it is pointing toward a board or a wall. The main purpose here is the creation of a uniform or otherwise pleasant luminance from the illuminated surface.

The criterion of emitter visibility is directly related to glare. If glare must be prevented by design, a direct configuration should only be used if the extended geometry of the application scene allows for it (considering the surroundings and possible observer positions). The importance of this issue changes with the source luminance (see previous section on LED specifications).

However, the use of secondary optics does not automatically reduce the luminance. For example, multiple reflections, unfortunately designed facets or a slightly misaligned emitter can create peaks of high intensity at glance angles. In virtual experiments, the luminance impression can be captured in a visualization of the ray-tracing process, using a luminance camera sensor, which essentially does the same job as a real camera. The luminance of a reflector from different viewing angles, on and off axis, provides not only information on the lit appearance of the light source, but also identifies sources of stray light. In Fig. 5, a luminance image of a PS reflector is shown. In particular, the fields of multi-source applications (such as multi-LED, or signaling devices) and the wide field of exterior automotive lighting design attach great importance to the smoothness and pleasantness of a light source's appearance when lit and also in daylight.

### LED street lighting

One of the hot topics in the lighting business these days is LED street illumination. This is a prominent playground for the direct vs. indirect discussion. As of today, almost all LED street lights are of direct kind. That is to some extent motivated by the available off-the-shelf parts (mainly TIR optics and emitter-specific reflector parts). Although an *a priori* selection of components creates a strong oppression on the optical design, this procedure is quite common.

A multitude of lenses or reflectors with different spread are the optical backbone of many LED street lights. Unfortunately, directional optics, such as TIR collimators, do not have a pleasant appearance to the human eye (glare), and today's compound eye-like streetlights, although innovative, will retreat into the background in the years to come. Wide-angle lenses (for example, of 120° × 60° rectangular spread), which allow identical emitters with identical optics to be mounted horizontally, appear to be a very promising direct approach. They produce a lower emittance than LEDs with directional optics. Thus, they reduce one major drawback of the direct arrangement, while they also can provide a sufficient light control for the task (a uniform road illumination/luminance). Sophisticated free-form lenses could dominate the short to medium longitudinal ranges (S,M type) in the future.

Indirect solutions offer better light control, like sharp cut-offs. Thus, they should be chosen for long-range street lights (M,L type). This being said, a semi-direct hybrid solution that uses direct light to illuminate the vicinity of the streetlight's pole, but also uses indirect reflector arrangements for wider angles would combine the best of both worlds.

# Taiwan develops LED Cluster in Southern Taiwan Science Park

Echoing the Taiwan government's plan to stimulate growth in both the LED and photovoltaic industries, the Southern Taiwan Science Park is aiming to create a significant photonics industry manufacturing base in the Southern Taiwan region.

Influenced by the economic downturn, the scale of Taiwan's LED epitaxy and packaging industry only reached NTD 82 billion (US$2.51 billion) in 2008, around the same level as in 2007. This fell a long way short of the expected NTD 100 billion. The revenue of Taiwan's LED epitaxy industry in 2008 was NTD 32 billion, representing a drop of 4% in comparison with the prior year. The LED packaging industry, on the other hand, had a low growth rate of around 3% in 2008, reaching NTD 50 billion (US$1.53 billion). Compared with the growth rates in the previous two years (see Fig. 1), this figure was not encouraging for companies in the industry. The four major markets of LED application are signal lighting, indicator lights for electronic products, cell-phone backlights, and automotive lighting. Increasingly, LEDs are being used for the purpose of energy saving and carbon reduction.

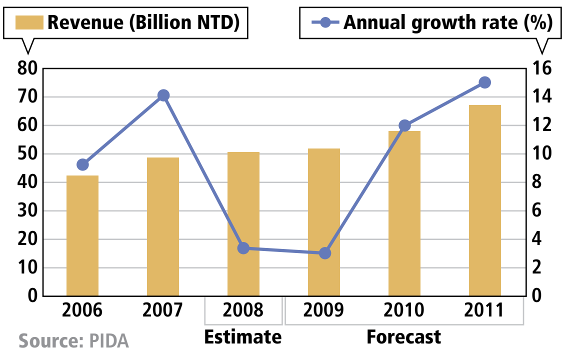



**FIGURE 1.** Revenue and growth rate of the LED packaging industry in Taiwan.

Eying the huge potential of the LED lighting market in Taiwan, and wishing to encourage "green energy" industry development, the Taiwan government has put a lot of effort into promoting LED lighting technology and creating national standards for LED roadway lighting. The Ministry of Economic Affairs (MOEA) has taken several actions to bring together the strengths of manufacturers, academia, research institutes and industry associations to jointly improve the competitiveness of Taiwan's LED lighting industry.

In 2007, MOEA announced it will spend NTD 2 billion (US$60.6 million) in the next four years to help develop the LED industry in Taiwan. It expects the industry to reach a value of NTD 540 billion (over US$16 billion) by 2015. Through ambitious investments and industry development plans, the government wishes to push Taiwan's global market share of the LED industry from around 14% in 2010 to 23% by 2015.

> The Taiwan government has put a lot of effort into promoting LED lighting technology and creating national standards for LED roadway lighting.

Furthermore, in June 2009, Taiwan's Legislative Yuan passed the Renewable Energy Act and approved a project for new industrial development related to solar energy and LEDs. The aim is to make Taiwan one of the world's top-three producers of solar energy batteries and the world's largest supplier of LED lights and modules. Taiwan will change all of its 700,000 traffic signals to LEDs and by 2011; in the meantime, the government aims to complete the construction of Asia's largest solar power plant.

It is expected that Taiwan's LED industry, the world's second largest by revenue, will benefit from the Act. The industry includes companies such as Arima Optoelectronics, Bright LED Electronics, Epistar, Everlight Electronics, Formosa Epitaxy, Genesis Photonics, Harvatek, I-Chiun Precision, Ligitek, Opto Tech, and Unity Opto Technology. Some of these are located in the Southern Taiwan Science Park (STSP).

### STSP shows green industry synergy

STSP is home to the most prominent TFT-LCD manufacturing chain in Taiwan, led by CMO, as well as leading green energy companies such as Epistar and Motech. The STSP

*The article was authored by the Southern Taiwan Science Park (STSP: www.stsipa.gov.tw) and the Photonics Industry and Technology Development Agency (PIDA: www.pida.org.tw).*

## Links

**EPILEDS TECHNOLOGIES INC.:** www.epileds.com.tw/epileds-en
**EPISTAR CORP.:** www.epistar.com.tw/about-e.htm
**FORMOSA EPITAXY:** www.forepi.com.tw
**GENESIS PHOTONICS:** www.g-photonics.com
**UBILUX OPTOELECTRONICS CORP.:** www.ubilux.com.tw/en

comprises Tainan Science Park (TSP) in Tainan County and Kaohsiung Science Park (KSP) in Kaohsiung County, with 2,577 and 1,409 acres, respectively. Embraced by two super-highways, STSP aims to be an advanced, multifunctional, and multinational industrial park. With the advantages of spacious land, cheap rent, and stable supplies of water and electricity, STSP has become an important site for technology innovation in Taiwan's photonics industry. The production value of STSP for LED epiwafers and PV cells is US$1.278 billion, representing 40% of total production in Taiwan.

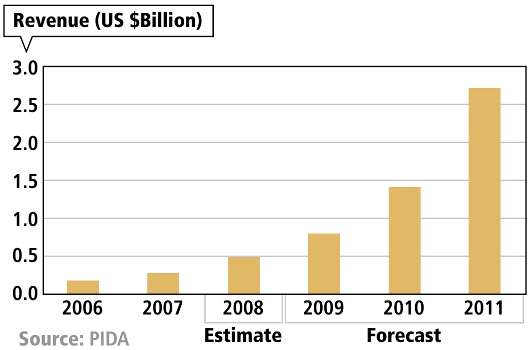



**FIGURE 2.** Global revenue of LED interior lighting.

Aiming to become a significant manufacturing base for the "green energy" industry (including both energy generation and energy conservation) in the Southern Taiwan region, STSP has formed a high-tech supply chain, which integrates academia, industry, and R&D resources and encourages industrial upgrade. The energy conservation side includes a number of LED companies, namely Epistar, Formosa Epitaxy, Genesis Photonics, Epileds Technologies, and Ubilux Optoelectronics. In the future, more relevant R&D institutes will be introduced to STSP to enhance the capabilities of the green energy industry.

### STSP attracts investment

Aiming to become a significant center for technological advancement, and emphasizing the preservation of nature, environmental protection, promotion of cultural activity, and high quality of life, STSP plans to establish a high-tech supply chain, integrating academia, industries and R&D and encouraging industrial upgrading in southern Taiwan. Moreover, STSP will join with other industrial and science parks to create the Southern Taiwan Technology Corridor, with the vision of a Green Silicon Island.

STSP will expedite the formation of key industry clusters, and has already established a photovoltaic industry hub and a medical device industry cluster. Also, STSP will build a safe and sustainable environment; including a comprehensive and effective disaster-prevention system, keeping STSP ahead of local and international science parks and industrial zones. Also, the TSP Resource Recycling Center will engage in the OHSAS18000 certification process. The achievement of being both ISO and OHSAS-certified will mean a safer and more environmentally-conscious work environment.

Although STSP has encountered some crises in the past, these were turned to opportunities. For example, the resonant vibration of the high-speed rail line once shattered the investment willingness of companies, but along with the completion of vibration reduction projects, the problem was solved. Besides, the high-speed rail has now become an important part of the STSP traffic network. With this tempo, STSP is going to embrace another ten years of success.

PIDA organizes the LED Lighting Taiwan event, to be held on June 9-11, 2010, at the Taipei World Trade Center.
**MORE:** www.optotaiwan.com/en.

# ANNOUNCING

# Strategies in Light® Europe

*The Leading Events for the Global LED and Lighting Industry*

**September 28-29, 2010** · Frankfurt, Germany · Sheraton Frankfurt Hotel & Towers, Conference Center

**Event Overview:**

## The Large and Growing Global HB LED and Lighting Market

For 10 years, Strategies in Light® Conference & Expo has grown to be the premier annual forum for presenting current commercial developments in high-brightness LEDs and most recently, lighting. Celebrating its 10th anniversary in 2009, Strategies in Light drew record-breaking attendance of more than 2,000 indicative that the interest in LED technology and markets remains undiminished and the long-term fundamentals for the LED and lighting industry remain strong. In 2008 to meet the demand for the large and growing HB LED and lighting market in Japan, LED Japan Conference & Expo/Strategies in Light® successfully debuted to more than 2,700 participants. This year's 2009 event in Japan exceeded 5,300 total participants.

## Join Us at Strategies in Light Europe

Strategies in Light Europe will focus on the LED industry supply chain, which results in products such as LED lighting fixtures (luminaires) and replacement lamps; automotive lighting; high-definition LED displays; backlighting for screens in TVs and laptops; and mobile devices, among others.

Discussions will cover LED systems and end products, LED light-engines and modules and the LEDs themselves, as well as critical components such as drivers and controllers, optics, thermal management and test and measurement. Speakers will focus on issues such as critical challenges and barriers to adoption; regulatory issues and standards; government support and funding; technology updates and roadmaps; financing, and the competitive landscape.

Europe has a robust LED applications environment, ranging from automotive lighting to outdoor signage to solid-state lighting. Moreover, all elements of the HB LED vertical supply chain are represented in Europe, ranging from substrates, to process materials and chemicals, to manufacturing equipment.

Whether you are a supplier, an LED manufacturer trying to reach new customers, a designer looking for new product information, or a buyer exploring the latest technologies, Strategies in Light Europe can help achieve your objectives.

### WHO WILL ATTEND

- LED lighting manufacturers
- Lighting designers, specifiers and architects
- LED product designers
- LED & lighting specialists working with:
  - Mobile Appliances
  - Signs and Displays
  - Automotive Lighting
  - Signals
  - Illumination
  - Electronic Equipment
- LED makers and distributors
- Energy-efficiency organizations
- Corporate R&D staff
- Government regulators and policy-makers
- Financial analysts, investment bankers, and venture capitalists

### APPLICATIONS INCLUDE

- General lighting/illumination
- Architectural and decorative lighting
- Mobile devices
- Outdoor lighting
- Signs and displays
- Automotive lighting
- Signals
- Backlighting

### WHO WILL EXHIBIT

- LED manufacturers
- Component distributors
- Driver and controller manufacturers
- Test & measurement providers
- LED lighting manufacturers
- Design software suppliers
- Equipment and materials suppliers
- Thermal management and optics suppliers
- Module and light-engine vendors

**www.sil-ledeurope.com**

### FOR MORE INFORMATION ON THE EVENT, PLEASE CONTACT:

UK Office
Paul Sweeney
International Events Director
Tel: +44 1992 656 623
Email: psweeney@pennwell.com

Germany/Austria Office:
Holger Gerisch
Sales Manager
Phone: +49-8801-302430
holgerg@pennwell.com

USA Office:
Tim Carli
Sales Manager
Phone: +1 650-941-3438 ext. 23
tcarli@strategies-u.com

Presented by: strategies unlimited · LEDs MAGAZINE

Owned and Produced by: PennWell® · LED & LIGHTING Media Group

# LEDs MAGAZINE webcasts

LED & LIGHTING Media Group

PennWell

strategies unlimited.

## Upcoming Sponsorship Opportunity

### High-Brightness LED Market Update and Forecast

**PRESENTED BY:** *Robert V. Steele, Ph.D., Director, Optoelectronics Strategies Unlimited, World's Leader in Photonics Market Research*

The HB LED industry is facing a rocky road in 2009, with several major applications, including mobile phones, automotive lighting, and outdoor signs experiencing significant downturns due to the worldwide economic recession. However, on the positive side, several emerging applications such as LED backlights for notebook computers and LCD TVs and monitors, as well as LED lighting, are experiencing substantial growth in spite of the general economic trends. Overall, the HB LED market is experiencing a modest decline in 2009; nevertheless the fundamentals underlying long term market growth remain sound. This webcast will provide details on the current and near-term market environment, and will provide a market forecast through 2013.

**SPONSORED BY:**

sapa:

NUVENTIX

## Next Event—October 29th

### Optimizing LED Performance Through Heat Management

**SPEAKERS:** *Martin Schon, Thermal Management Product Manager, Sapa Extrusions*
*Mick Wilcox, Director of Marketing, Nuventix*

As product designers develop higher powered LEDs for the lighting, medical and home entertainment product markets, thermal management increasingly becomes an obstacle. This Webcast discusses the effect of heat on LED fixtures, and describes how thermal management techniques involving heat sinks and active cooling can assist in product design.

## Archived Events

Intertek

labsphere 30th Anniversary

### Solid-State Lighting: Safety Certification Process and Performance Testing Measurement Techniques

**SPEAKERS:** *Greg McKee, Director Systems Business Unit, Labsphere*
*Todd Straka, Director - Lighting Services, Intertek*

As the solid-state lighting industry continues to grow, customers need to be reassured that the products they are purchasing will exhibit stated performance levels while also meeting any applicable standards. This Webcast discusses techniques for test and measurement, as well as the process of safety certification.

AVNET electronics marketing

### Challenges and Opportunities in the LED Lighting Fixture Market

This Webcast discusses the key factors affecting the penetration of LED lighting fixtures into the general lighting market.

MAXIM

SphereOptics

### LED Luminaire Photometry & Performance Testing

This Webcast discusses the fundamental aspects of performance testing of solid-state lighting fixtures, covering recently-introduced standards and equipment options

VIEW ALL CURRENT, FUTURE AND ARCHIVED EVENTS AT:

**www.ledsmagazine.com/webcasts**

# Operational demands of LED lighting put pressure on driver IC performance

The acceleration of white LED lighting applications has created many specific performance requirements for high-current LED driver ICs, maximizing efficiency and ruggedness while minimizing the transition cost for the user, writes **JEFF GRUETTER**.

One of the biggest challenges to lighting systems designers is how to optimize all the benefits of the latest generation of LEDs. As LEDs generally require an accurate and efficient DC current source and a means for dimming, the LED driver ICs must be designed to address these requirements in a wide variety of applications. Power solutions must be highly efficient, robust, very compact and cost effective.

In lieu of a high-voltage AC power source preferred by incandescent, fluorescent, and HPS bulbs, LEDs generally use a much lower DC voltage source typically ranging from only 8 to 72 V, depending on the application and the LED configuration. However, most new designs will operate with inputs from 12 to 24 V DC, while some retrofit designs will use a 12 V AC input.

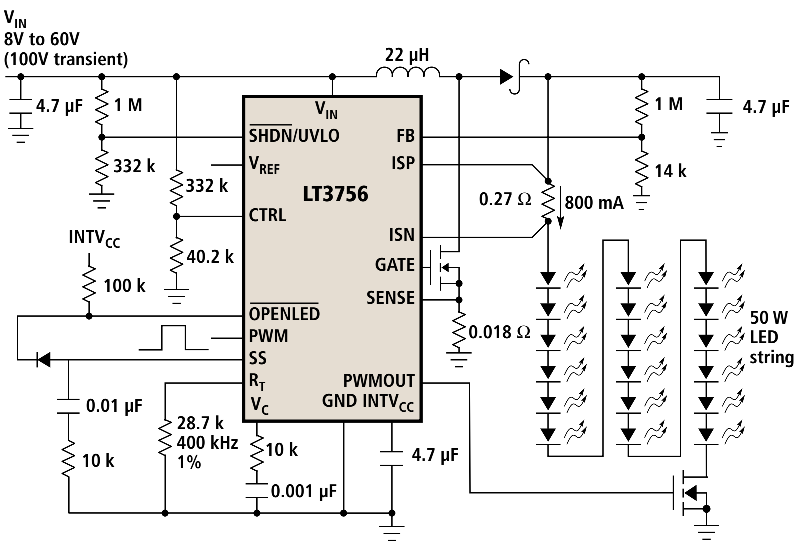



**FIGURE 1.** A 50W LED boost circuit.

To ensure optimal performance and long operating life, LEDs require an effective drive circuit. These drive circuits must be capable of operating from a loosely regulated power rail, and also be both cost- and space-effective. In order to maintain their long operating life, it is imperative that an LED's current and temperature limits are not exceeded.

It is also important that an LED driver delivers constant current to the string of LEDs, regardless of variations of the input voltage, to maintain constant light output and color. For this reason, a constant-frequency, current-mode LED driver topology is usually required. Compared to voltage-mode control, current-mode control improves loop dynamics and provides cycle-by-cycle current limit and a constant current to the LED. Finally, LED drivers must deliver efficiencies in excess of 90% to minimize the need for external heat sinking and to maintain the high efficiency of the lighting system.

Fig. 1 shows a typical 50 W LED string driven by a single LED driver IC. The design can be implemented in a number of different configurations. The LEDs could be arranged in a single array in a 50 W spot light configuration to replace a 125 W fluorescent or HPS lamp, all of which are equivalent to the light output of a 500 W halogen bulb with a very small percentage of its dissipated heat. In addition to the energy savings, the design would offer instant-on capability, a much cleaner color of light and the ability to quickly and accurately dim the LEDs. Alternatively, the LEDs could be configured as track lamps with up to fourteen 4 W LEDs. Each lamp would deliver light output equivalent to a 40 W halogen bulb with equal or better light color, while reducing the inherent fire risk of a very hot halogen bulb. Similarly it could replace several fluorescent bulbs.

The driver IC, Linear Technology's LT3756, incorporates a high-side current sense, enabling it to be used in boost, buck, buck-boost, or SEPIC and flyback topologies. In this example, the IC is used in boost mode and can deliver efficiencies of over 94%, eliminating any need for heat sinking and minimizing thermal concerns.

The LT3756 has a 6 to 100 V input voltage range and can drive up to fourteen 1A white LEDs from a nominal 12 V input, delivering in excess of 50 W. From a 24 V input, it could power up to 20 LEDs offering a total of 75 W of LED power. A frequency-adjust pin permits the user to program the frequency between 100 kHz and 1 MHz, optimizing efficiency while minimizing external component size and cost.

Furthermore, the LT3756 uses True Color PWM dimming, which delivers constant LED color with dimming ranges of up to 3,000:1.

JEFF GRUETTER *is a Product Marketing Engineer with Linear Technology (www.linear.com).*

For less demanding dimming requirements, the CTRL pin can be used to offer a 10:1 analog dimming range. Its fixed-frequency, current-mode architecture offers stable operation over a wide range of supply and output voltages. A ground-referenced voltage FB pin serves as the input for several LED protection features, making it possible for the converter to operate as a constant-voltage source.

**FIGURE 2.** Refinery with white LED lighting at left and high-pressure sodium (HPS) lighting at right.

### Industrial lighting

To emphasize the benefits of industrial LED lighting versus the historically most efficient HPS lighting, one can consider a refinery at which more than 1,000 250 W HPS fixtures were replaced with the same number of 100 W white HB-LED fixtures powered by the LT3755 (see Fig. 2). Because these lights are on 24/7, the first major benefit is a 60% reduction in energy requirements, which translates into a cost saving of $164,000 per year (at $0.10 per kWh). This saving could be dramatically increased, as the LED fixtures do not require any warm-up period and can be operated as "instant-on." Thus, the plant could save a lot more energy by powering the lights down when not needed or by using motion-control sensors to avoid running them 24/7.

Another major benefit is the quality of the light output. As can be seen in Fig. 2, the section of the plant on the left side is illuminated with LEDs and delivers a pure full-spectrum white light, under which it is much easier to see compared to the HPS lamps (right side), which emit light almost exclusively in the orange area of the color spectrum, making it very difficult to differentiate colors. In a refinery, this is especially critical as it is very important to visually distinguish steam from the smoke of a fire. Also important is the ability to accurately decipher color-coded wiring and colored plaques, even in low-light conditions.

Finally, with an operating lifetime of 100,000 hours, the white LEDs will last more than 11 years running 24/7, compared to the HPS lamps, which require replacement every year or two. This further reduces the overall long-term cost of the HB LEDs when compared to the current HPS lighting.

### Conclusion

The unprecedented acceleration of white LED lighting applications in industrial/residential general lighting has created many performance requirements for high-current LED driver ICs, maximizing efficiency and ruggedness while minimizing the transition cost for the user. These LED drivers must provide constant current to maintain uniform brightness, regardless of input voltage or LED forward-voltage variations, as well operate with high efficiency and offer wide dimming ratios. Applications also require very compact, thermally efficient footprints. Designers of LED drivers have designed ICs to satisfy all of these requirements.

# PRODUCT *focus*

TO PROMOTE YOUR PRODUCT HERE, PLEASE CONTACT **JOANNA HOOK** AT *joannah@pennwell.com* OR **MARY DONNELLY** (U.S. SALES) AT *maryd@pennwell.com*

# LED market stumbles in 2009, but long-term outlook remains bullish

The LED market is expected to decline by 3.7% this year, but the fundamental drivers for LED adoption have not weakened, says **BOB STEELE** of **STRATEGIES UNLIMITED**.

The worldwide economic recession has had a negative impact on many industries, including high-brightness LEDs. Although market growth for 2008 was positive (+11%) despite a shaky fourth quarter, a decline of 3.7% is expected for this year, resulting in a market size of $4.9 billion. However, this decline will not affect all LED market segments equally. For example, although some of the more mature markets such as automotive lighting and mobile phones are experiencing substantial downturns, other emerging segments, such as backlights for LCD displays in notebook computers and TVs, are showing strong growth. Moreover, the LED lighting market is also continuing to grow, although at a somewhat slower pace than in recent years.

Since Strategies Unlimited began tracking the LED market in 1995 there has never been a down year, although the market in 2001 was flat. However, that was during a worldwide recession in which all other technology-based markets experienced dramatic downturns (for example, the silicon semiconductor market contracted by 32%). In the current economic environment, it is not surprising that a number of end-use sectors that consume LEDs are experiencing downturns. Worldwide automobile production is expected to shrink by 20% in 2009, while mobile phone handset shipments are expected to decline by 10% in 2009 after years of steady growth. These two segments accounted for 15% and 42%, respectively, of LED consumption in 2008.

However, in all market segments, the penetration rates for the use of LEDs continue to grow. The fundamental drivers for LED adoption have not changed. It is the impact of the worldwide economic recession on end-product demand, rather than any slowdown in the rate of LED adoption, that is causing the LED market to dip in 2009. Moreover, as noted above, not all segments are suffering downturns.

The use of white LEDs for LCD display backlights in notebook computers began in 2005, and by 2008 LED penetration had reached 12%. This figure is expected to reach 50% in 2009. Because of the improving price/performance situation of white side-view LEDs, and the advantage of longer battery life provided by more efficient LCD backlights, the adoption of LED backlights in notebook PCs can be considered to be a "done deal." It will reach close to 100% within a few more years.

LED backlights for LCD TVs are in a much earlier stage of development, but the market is beginning to accelerate this year, thanks to the efforts of Samsung, LG, Sharp, Sony, and other TV manufacturers. Samsung is the most aggressive, reportedly spending $35 million on an ad campaign to promote its "LED TVs," and it has forecast sales of two million sets in 2009. However, introduction of an expensive product ($700 to $800 higher in price than conventional CCFL-backlit LCD TVs) during a worldwide economic recession is likely to be a tough sell. Over the longer term, as the price differential between LED and conventional TVs comes down, we expect the market for backlights to be the largest contributor to LED market growth, reaching billions of dollars by 2013.

In spite of the recession, which has resulted in significant sales declines for established lighting product companies, LED lighting continues to have strong momentum. The number of new products being introduced to the market, and the number of companies offering LED lighting products, has increased dramatically in 2009. In 2008, the consumption of LEDs in lighting applications increased by 54%. In 2009, we expect growth on the order of 15%, increasing to between 40% and 50% growth in the years following economic recovery. Lighting efficiency, promoted by various government policy initiatives around the world, will become the main driver for growth. This segment will become the second largest LED application (after backlights) by 2013.

We believe that not only have the fundamental drivers for LED adoption not weakened during the current recession, but also that they have become even stronger, as the emerging markets for LEDs in lighting and backlights open up new large-volume markets that were not available in earlier years. Overall, we are forecasting the LED market to grow from $5.1 billion in 2008 to $14.9 billion in 2013, which represents a compound annual growth rate of 24.0%.

**MORE:** www.ledsmagazine.com/strategies


Sourcing Regional Distributor
LED T8 TUBE
ENERGY SAVING LIGHT - LIGHTEN FUTURE
LED Panel Light
1200×300mm
600×600mm
JIUZHOU
SINCE 1958
E-mail:tango.liu@scjz-led.com
Tel:+86-755-26947007
Fax:+86-755-26715369
Website:www.jiuzhou.com.cn
www.jz-led.com