LED Lighting

--Global Manufacturing Trends

By
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Strategies Unlimited
June 13, 2012
Outline

• About Strategies Unlimited
• Lighting Industry
• LED Packaging
• LED Lighting
• Outlook
About Strategies Unlimited

- Market **research** and consulting firm - founded in 1979
- Long history of market research
  - photovoltaics,
  - compound semiconductor materials and devices,
  - image sensors and lasers
- Have followed the LED market since 1994
- Reports on
  - overall HB LED market (annual),
  - LEDs in lighting (annual),
  - LED luminaire market,
  - LED driver ICs, and
  - LED replacement lamp market
  - LED outdoor lighting market
- **Annual LED industry conference, Strategies in Light,** since 2000
- Acquired by PennWell Corporation in 2001
About PennWell

Connecting you with your target audience through industry intelligence in print, online and face-to-face events

**Market Research**
Strategies Unlimited
• HB LED & LED lighting
  • market research
• Custom Reports

**Events**
Strategies in Light; US, EU, Japan and China
The LED Show

**LEDs Magazine**
• 9 issues annually including Suppliers Directory
• Circulation – 55,000+
• Bonus Distribution at LED & Lighting industry shows/events

**Digital Media**
LEDs Magazine Online
• 414,000+ monthly page views
• 82,000 unique monthly visitors
  • webcasts
  • video
  • eNewsletters
  • white papers
  • editorial guides
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Lighting Industry

• **Lamps**—Light source
  – Technologies include Incandescent, Halogen, Compact fluorescence (CFL), Linear Fluorescent Tubes (LFT), High Intensity Discharge (HID) includes, Mercury Vapor (MV), Low Pressure Sodium (LPS), High Pressure Sodium (HPS), Metal Halide and Ceramic Metal Halide, Induction, and LED

• **Fixtures**—does not include the light source

• **Ballasts**
  – Power Management

• **Luminaires**
  – Light Source + Fixture
    – New nomenclature for SSL
    – Convergence of light sources, ballasts and fixtures

• **Controls**
  – Lighting system controls including Dimmers, Color dials, Mood Lighting, Wall plug controls, facility wide lighting controls, wi-fi, radio and internet controls
US Lighting Industry

Source: Bureau of Economic Affairs
US Market for Lighting

US Market ( $ Millions)

Source: International Trade Administration, Department of Commerce, U.S. Bureau of Economic Analysis
Estimated Inventory of Lamps in the U.S

Total: 8.2 Billion Lamps

By End-Use Sector

- Residential: 71%
- Commercial: 25%
- Industrial: 2%
- Outdoor: 2%

By Light Source Technology

- Incandescent: 45.1%
- Halogen: 3.8%
- Compact Fluorescent: 18.9%
- Linear Fluorescent: 29.1%
- High Intensity Discharge: 1.7%
- Other: 1.4%

Source: 2010 U.S. Lighting Market Characterization, DOE
Lumen Output & Energy Used

By Lumen Output

- All Sectors
- Outdoor
- Industrial
- Commercial
- Residential

By Energy Used

- All Sectors
- Outdoor
- Industrial
- Commercial
- Residential

Source: 2010 U.S. Lighting Market Characterization, DOE

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Energy Used by Lamp Type in US

Source: 2010 U.S. Lighting Market Characterization, DOE
Average Lighting Efficacies in US

Source: 2010 U.S. Lighting Market Characterization, DOE
More Changes Expected...

- Incandescence under pressure to improve efficiencies

- Prices of fluorescent phosphors are increasing and supply is limited, 2011 saw lamp price increase 10-25%

- High efficiency standards for ballasts for fluorescence as well as metal halide light sources
Lamp Manufacturing

- Mass Commodity Market
  - High volume, low margin
  - Manufacturing scaled to reduce cost
  - China is largest manufacturer with established supply chain
  - India, Bangladesh, Vietnam increasingly participating in manufacturing
  - Some specialty lamp manufacturing scattered in industrialized countries

- Few large players dominate
  - Philips, GE, Osram, Sylvania, Toshiba

- Many medium scale companies with manufacturing in China—TCP, Satco, Feit
Fixtures

• Fragmented manufacturing,
  – now mostly in China
• Large scale manufacturing of commercial lighting fixtures
• Large number of product types-SKU
• Access to channels key competitive requirement for introducing new products
• Dependent on customer service—either offered by distributors or manufacturers representatives
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LED Applications—Market Segments

- Signs
- Lighting
- Mobile
- TV/Monitor Display
- Automotive
LED Packages 2009-2011

Revenue in $ Billion

- 2009: $5.4
- 2010: $11.2
- 2011: $12.5
Market for LED Packages

2011 Market = US$12.5B

- Backlight TV/Monitor: 24%
- Mobile: 23%
- Sign: 11%
- Lighting: 16%
- Auto: 9%
- Others: 17%

Source: Strategies Unlimited
LEDs in Lighting

Revenues in $ Millions

Commercial/Industrial
Replacement Lamps
Architectural
Retail Display
Outdoor Area
Consumer Portable
Entertainment
Residential
Emergency Lighting
Off-grid

CAGR 10%

2011 Worldwide Supplier Ranking

1. Nichia
2. Samsung LED
3. Osram Opto
4. LG Innotek
5. Seoul Semiconductors
6. Philips Lumileds
7. Sharp
8. TG
9. Everlight

Billion $ Club

68%

Japan
30%

Korea
26%

China
6%

US/Europe
19%

Taiwan/SE Asia
19%

2011 Market
US$12.5B

Source: Strategies Unlimited
LED Industry-2011

- Slower than expected penetration in TV and Display market led to overcapacity in manufacturing and packaging LEDs in Taiwan and Korea
- Subsidies in China increased manufacturing capacity
- Attrition and consolidation has started in China
- It is expected to take 2 to 3 years before the overcapacity is worked out

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LED Performance

**Lumens/Watt**

- **Cool White**
- **Warm White**

**Price$/kilolumen for 1W High-Power LED with CRI: > 75**
- $2700 K per 1 W package: $8.50
- $3000 K per 1 W package: $7.50
- $3000 K - 4000K per 1 W package: $5.00
- $4000 K and up per 1W package: $4.50

Source: Strategies Unlimited

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Trends in LED Packaging

• LED Count dropping fast
• Prices dropping even faster
  – 35% to 45% reduction in prices of LED chips in 2011
  – 30-35% decline in prices of LED packages
  – Price of low end products declined faster than the high end

• Major growth in the use Low & Mid power LED for ambient lighting applications
• Koreans and Taiwanese have excess capacity to package mid-power and low power LEDs
• Increasing use of Multichip Arrays/COB for lighting applications
• All major suppliers offer multi-chip/COB/ arrays
• Prices of mid-power and low power dropped the fastest
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LED Lighting Market Segmentation

- LED Lighting Market
  - Replacement Lamps
  - Luminaires
LED Lighting Market Segmentation

LED Lighting Market

Replacement Lamps

- A19
  /Standard
- PARS
- MR16
- Candelabras
  /Globes/
  Decorative
- L T F

Luminaires
LED Lighting Market Segmentation

LED Lighting Market

Replacement Lamps

Luminaires

- Architectural
- Entertainment
- Retail display
- Residential
- Commercial /Industrial
- Consumer Portable
- Safety & Security
- Outdoor
- Off-grid /(Solar Powered)
LED Lighting

2010 Rev: $5.5B

2011 Rev: $9.9B

Source: Strategies Unlimited
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Looking Ahead

2010 Total Cost Index=100

2015 Total Cost Index=20

Based on calculations for downlights in the DOE SSL 2011 Manufacturing Roadmap

CAGR 2010-2015

- Total cost: -28%
- LED: -35%
- Mechanical / Thermal: -20%
- Driver: -24%
- Optics: -17%

Assembly, 5
Optics, 10
Driver, 20
Mechanical / Thermal, 15
LED, 50
Optics, 4
Driver, 5
Mechanical / Thermal, 5
LED, 6
Assembly, 0
Targets for LED Lamps in the U.S

Total: 8.2 Billion Lamps

By End-Use Sector
- Residential: 71%
- Commercial: 25%
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By Light Source Technology
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- High Intensity Discharge, 1.7%
- Other, 1.4%

Source: 2010 U.S. Lighting Market Characterization, DOE
Residential Sockets

Average Lamp Distribution in Residences in US

By Room Type

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Incandescent</th>
<th>CFL</th>
<th>LFT</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dining Room</td>
<td>66%</td>
<td>23%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Bathroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living / Family Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>50%</td>
<td>23%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Closet</td>
<td>50%</td>
<td>23%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laundry / Utility Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basement</td>
<td>50%</td>
<td>23%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Garage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Incandescent + Halogen 66%
CFL 23%
Linear Fluorescent Tubes 10%
Others 1%

Source: 2010 U.S. Lighting Market Characterization
LED Lamp Market

- Majority residential
- Sold through retail channels
- Lower value placed on cost of maintenance and extended life
- Most lamps used only for a short time in a day
- The perceived payback period should be less than one year (CFL experience!)
- Rebates subsidies need prices associated with commoditization

Dimensions of Consumers’
- Perceived Value
- Price/value for money
- Emotional
- Social, quality/performance
Perceptions

How much of a difference do you think the actions of individuals like yourself can make when it comes to solving the country’s energy problems? Can your actions make........

– A very large/large difference 41%
– A moderate difference 28%
– Small or no difference 31%

Source: Conducted by The Associated Press-NORC Center for Public Affairs Research
Interview dates: March 29 – April 25, 2012
CFL Market

Source: NEMA
Replacement Lamp

Revenue CAGR 2011-2016 11%

CAGR of Units 2011-16 By Region

Source: Strategies Unlimited
Opportunities in Commercial

Commercial Sector: Lamp Distribution by Commercial Building Type in 2010

Source: 2010 U.S. Lighting Market Characterization, DOE
Commercial & Outdoor

Source: 2010 U.S. Lighting Market Characterization, DOE
Luminaires

Not yet Commoditized!

- Rethinking about use of light, cost of light
- Disruptive Technology
- Premature standardization can lead to suboptimal use of technology
- Time to work out form factors that can be standardized
- Trade off between quality and cost
  - to the individual,
  - to the society

– Potential to offer quantity, quality and control over light
LED Luminaire Revenue Forecast

Revenues in US $ Millions

CAGR 19%

Growth Markets for LED Lighting

• Retrofit market in OECD countries
• New Construction in Emerging Economies
  – Population growth
  – Urbanization
  – Rise of new middle class
  – Increasing ranks of the rich*

*Upper Middle class spending in China as a percentage of luxury-goods market
  – 12% in 2010
  – 22% in 2015

Source: McKinsey
Luminaire vs Replacement Lamp

Revenues in US $ Millions

CAGR 19%

CAGR 11%
Regulatory Outlook

- Standards setting is moving rapidly,
  - consistency between regions-IEA-4E-Harmonization of Standards—a Global effort
- Standardization of product interfaces —drivers, dimmers, controls – Zhaga
- Many countries now recognize the importance of standards including China, and India
  - S DOE Efforts to set standards and CALiPER testing has far reaching global influence
- Europe:
  - CELMA-Optical Safety, Color Quality and other standards
  - ErP Directive (Ecodesign Requirements for Energy-related Product, Directive 2009/125/EC) –will be reviewed in 2014
  - 20-20-20 target for EU
  - Carbon Reduction Commitments (CRC) in UK
- ASHRAE Releases 90.1-2010
GDP Growth rates

Source: World Bank
Urbanization

Distribution of the world urban and rural population by major area

Urbanization

![Urbanization Bar Chart]

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China—a closer look at the market

- LED lighting revenues in 2011 are estimated to be 34% of the total market
- The 12th Five Year Plan includes subsidies for LED lighting products—mostly LED replacement tubes and lamps
- Mining, manufacturing, converted to LED
- Very enthusiastic user of LED building decoration lights
- The 21-city program installed hundreds of thousands of streetlights
- LED is identified as the next generation energy efficient technology
- China has more building space than any other country in the world
- Urbanization:
  - In 2010, 53% of the population lived in rural areas.
    In 2011, 21 million people moved to the cities.
    By 2012 majority (> 50%) of the people lived in urban areas.
    In the next 20 years 75% of the population is expected to live in urban areas.
- New Public Housing units
  - 10 million in 2011
  - 7 million in 2012

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China—a closer look at the industry

• GGLED estimates about 60% of global LED products in all applications are manufactured in China
• There are over 4000 enterprises—mostly small
  — About 13% are only tube manufacturers, 10% manufacture only bulbs
• Active IPO scene
  — 2010: Nationstar Optoelectronics Co., Ltd. and Changelight Co., Ltd.
• IPOs of Chinese companies outside China:
  — China Intelligent Lighting
  — TCP filed for IPO in April 2012 (Revenue: $281 million in 2011)
• Recent Bankruptcies: JDL Enterprise Group, Bolunte Optoelectronics Technology Co., Ltd. of Shenzhen
New Applications

Source: Hera

Source: C3 Continental Case Lighting

Source: Bosch Appliances
New Applications

Source: Grupo MCI
Mundocolor Iluminación Técnica y Mundolighting
Thank you

Questions?

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