LED Lighting Market Trends and Intelligent Wireless Lighting Control

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March 2012
Introduction

- Lighting currently represents 17.5% of global electricity consumption.
  - EMSD: lighting is the second largest electricity consumption in HK
- There is growing trend to use LED to replace traditional lighting:
  - Technical: Energy saving (>30%), long operating hours (>35,000 hrs), non toxic, etc.
  - Government initiative: energy saving policy
- What’s next when LED is becoming mature?
  - Answer: intelligent wireless lighting control
  - Further increase energy saving capability i.e. sensor control
  - Increase competitiveness in lighting market
LED Lighting Update
LED Package Market Revenue

LEDinside 2011

ASTRI Proprietary
LED Fixture Market Revenue

Strategic Unlimited 2011

ASTRI Proprietary
# Traditional Light Sources

<table>
<thead>
<tr>
<th>Type</th>
<th>Wattage (W)</th>
<th>Luminous flux, init. (avg) (lm)</th>
<th>Efficiency (lm/W)</th>
<th>$R_a$</th>
<th>CT (CCT) (K)</th>
<th>Lifetime (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent (120 V)</td>
<td>60</td>
<td>865</td>
<td>14.4</td>
<td>100</td>
<td>2790</td>
<td>1000</td>
</tr>
<tr>
<td>Tungsten halogen (120 V)</td>
<td>50</td>
<td>590</td>
<td>11.8</td>
<td>100</td>
<td>2750</td>
<td>2000</td>
</tr>
<tr>
<td>Fluorescent triphosphor</td>
<td>32</td>
<td>2,850 (2,710)</td>
<td>84</td>
<td>78</td>
<td>(4100)</td>
<td>24,000</td>
</tr>
<tr>
<td>Compact fluorescent</td>
<td>15</td>
<td>900 (765)</td>
<td>51</td>
<td>82</td>
<td>(2700)</td>
<td>10,000</td>
</tr>
<tr>
<td>Low-pressure sodium</td>
<td>90</td>
<td>12,750 (11,095)</td>
<td>123</td>
<td>-44</td>
<td>(1800)</td>
<td>16,000</td>
</tr>
<tr>
<td>High-pressure mercury</td>
<td>250</td>
<td>11,200 (8,400)</td>
<td>34</td>
<td>50</td>
<td>(3900)</td>
<td>24,000</td>
</tr>
<tr>
<td>High-pressure sodium</td>
<td>250</td>
<td>28,000 (27,000)</td>
<td>108</td>
<td>22</td>
<td>(2100)</td>
<td>24,000</td>
</tr>
<tr>
<td>Metal halide</td>
<td>400</td>
<td>36,000 (24,000)</td>
<td>60</td>
<td>65</td>
<td>(4000)</td>
<td>20,000</td>
</tr>
<tr>
<td>Induction</td>
<td>55</td>
<td>3,500 (2,800)</td>
<td>64</td>
<td>80</td>
<td>(3000)</td>
<td>100,000</td>
</tr>
</tbody>
</table>
LED vs Traditional Light

Data FIVE years ago!
LED Efficiency

Evolution of white LED efficacy
Best available commercial products

Data TODAY!

Strategy Unlimited 2011
ASTRI Proprietary
Average 1W LED cool white package
## LED Performance

### Table 1. 6000-Hour Lumen Maintenance Thresholds

<table>
<thead>
<tr>
<th></th>
<th>Minimum lumen maintenance at end of 6000 hours (% of initial lumens; -3% tolerance)</th>
<th>Maximum L$_{70}$ Life Claim (hours)</th>
<th>ENERGY STAR Approval Available After 6000-hour test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum for Decorative</td>
<td>86.7%</td>
<td>15,000</td>
<td>Full approval (no additional lumen maintenance testing required)</td>
</tr>
<tr>
<td>Optional for Decorative</td>
<td>89.9%</td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td>Minimum for Non-standard, Omnidirectional, and Directional</td>
<td>91.8%</td>
<td>25,000</td>
<td></td>
</tr>
<tr>
<td>Optional for Decorative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optional for All Lamp Types</td>
<td>93.1%</td>
<td>30,000</td>
<td>Initial approval, pending completion of total required test period (see Table 2 below)</td>
</tr>
<tr>
<td></td>
<td>94.1%</td>
<td>35,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>94.8%</td>
<td>40,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.4%</td>
<td>45,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.8%</td>
<td>50,000</td>
<td></td>
</tr>
</tbody>
</table>

### Energy Star Lumen Maintenance Requirements
Wireless Lighting Control
Advantages

- **Cost reduction**
  - Low installation cost due to reduction of wiring of cables
  - Extra power saving with sensors e.g. motion sensor, daylight sensor, etc.

- **Increase flexibility**
  - No limitation in installation of control device e.g. battery operated wall switch, sensors, etc.
  - Remote controllable of lighting device e.g. remote controller, tablet, smartphone, etc.

- **Advanced control**
  - Time scheduling
  - Individual, group control
  - Color mixing, CCT tunable, etc.
Lighting Control Technologies

- **Manual control**
  
  Wall switch, remote controller, etc.

- **Automatic control**
  
  - Scheduling
  
  - Daylight sensor
  
  - Motion sensor

![Energy saving capability for different types of control technologies](chart.png)
User Scenario

- Daylight sensor
- Wireless wall switch
- Motion sensor
- Time scheduling from central control

Office

Corridor

Staircase

Remote control
Market Trends

- **Global market size** *(source: Pike Research 2010):*
  - Global revenue of lighting control will increase from US$1.3B to $2.6B by 2016
  - Wireless technology in building management system → 73% retrofit

![Wireless Sensor Network Market Forecast](image1)
![Intelligent Building Automation Technologies Market Forecast](image2)

- **Government initiative in Hong Kong:**
  - EMSD – The Building Energy Efficiency Ordinance (Cap.610)
  - Housing Authority – Target to save 20% energy in lighting by adopting control system
# Wireless Technologies Comparison

<table>
<thead>
<tr>
<th>Market Name Standard</th>
<th>ZigBee™ 802.15.4</th>
<th>GSM/GPRS CDMA/1xRTT</th>
<th>Wi-Fi™ 802.11b</th>
<th>Bluetooth™ 802.15.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Focus</td>
<td>Monitoring &amp; Control</td>
<td>White Area Voice &amp; Data</td>
<td>Web, Email, Video</td>
<td>Cable Replacement</td>
</tr>
<tr>
<td>System Resources</td>
<td>4KB - 32KB</td>
<td>16MB</td>
<td>1MB</td>
<td>16KB</td>
</tr>
<tr>
<td>Battery Life (days)</td>
<td>100 - 1,000</td>
<td>1 - 7</td>
<td>.5 - 5</td>
<td>1 - 7</td>
</tr>
<tr>
<td>Network Size</td>
<td>Unlimited</td>
<td>1</td>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td>Bandwidth (KB/s)</td>
<td>20 - 250</td>
<td>124 - 68</td>
<td>11,000</td>
<td>720</td>
</tr>
<tr>
<td>Transmission Range (meters)</td>
<td>1 - 100</td>
<td>1,000</td>
<td>1 - 100</td>
<td>1 - 10</td>
</tr>
<tr>
<td>Success Metrics</td>
<td>Reliability, Power, Cost</td>
<td>Reach, Quality</td>
<td>Speed, Flexibility</td>
<td>Cost, Convenience</td>
</tr>
</tbody>
</table>
Why Zigbee?

- **Low power consumption**
  Long battery life > 2 years

- **Reliable wireless network**
  Mesh network for self healing

- **Interoperable**
  Zigbee already products

- **Open standard for lighting**
  Application profile “Light Link” (2012) for user friendly lighting control with internet access
ASTRI Wireless Lighting
Control Technology
ASTRI’s MPT Group

Green Energy
- CPV
- Concentrating Wind Charger
- Fuel Cell
- Li-ion Battery Anode Materials

LED
- Indoor, Outdoor Lighting & Control
- 3D Pico-projectors
- Touch Panel & Intelligent Display

Packaging & Sensing
- Printed Electronics
- TPMS
- SiP
- Anti-counterfeit Identification
- Healthcare Electronics
- Anti-shaking, Auto-focus & Optical Zoom Camera

- 173 US patents filed,
  60 US granted/allowed,
  88 counts licensed
- 127 technologies transferred to
  75 companies,
  1 spin-off
- 17 major awards from HK,
  China, US, Japan & Korea
Development Direction

- **Green**
  Target to develop energy saving wireless lighting control system for home & building automation

- **Low cost**
  Implementation using commercial available components, function enhancement with simple modification & algorithm

- **Retrofit**
  Wireless, embedded design → Simple installation without re-wiring

- **Intelligent**
  Fully automation, interacts with environment & human
Low cost, intelligent & flexible wireless sensor network for green building

- Motion sensor
- Temperature sensor
- Daylight sensor
- Power monitor
- Internet
- Zigbee gateway
- Control & monitoring
End of Presentation
Thank you. Questions are welcome.

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