LED Industry – A Brief Introduction

Ishiang Shih

ECE Department

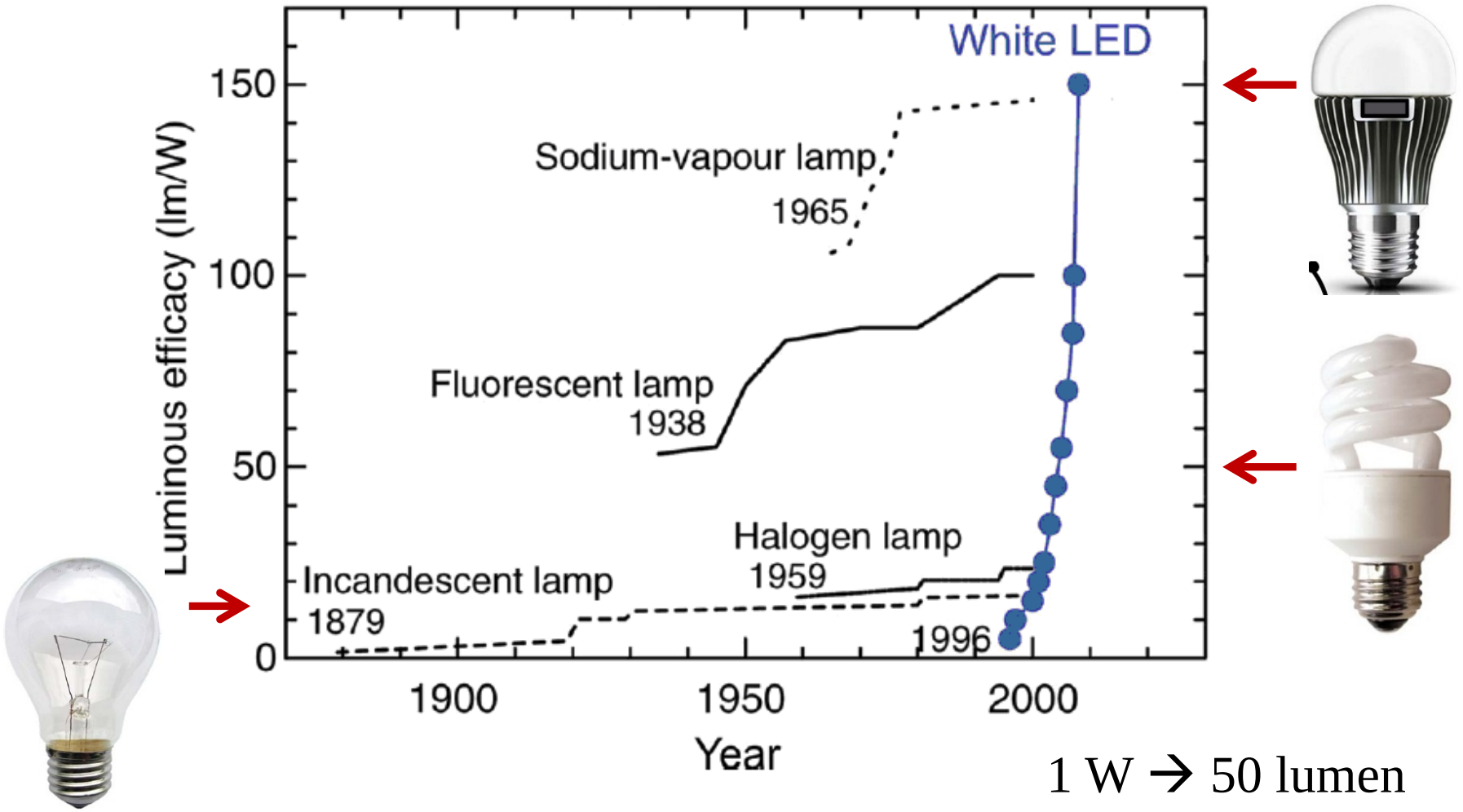
McGill University

514-398-7147

Ishiang.shih@mcgill.ca January 11, 2013

[1] Brief Introduction: Comparison of three lighting technologies

1 W → 150 lumen

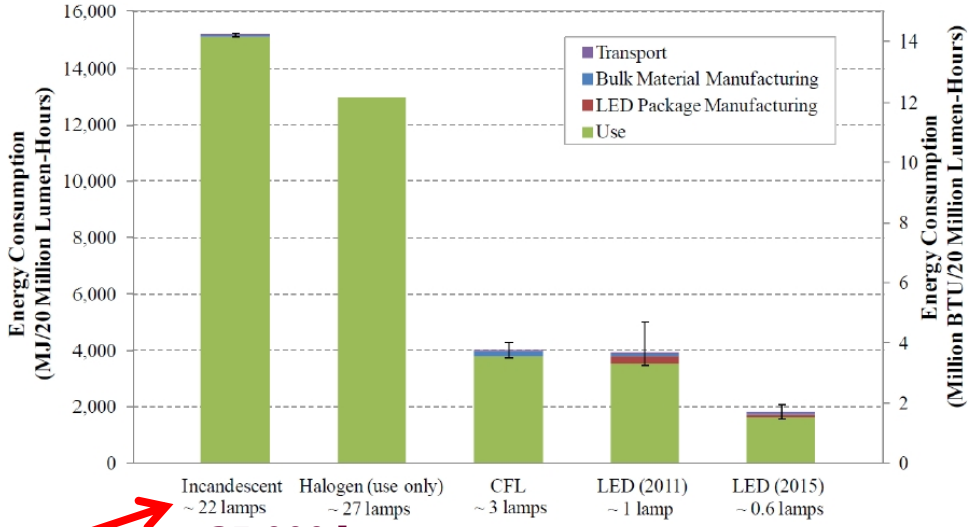


1 W → 50 lumen

1 W → 12.5 lumen
1 candela → 12.57 lumen

Luminous efficiency is the key figure in the selection of lighting technology.

Life-cycle energy of incandescent lamps, CFLs and LED lamps (DOE, 2012)

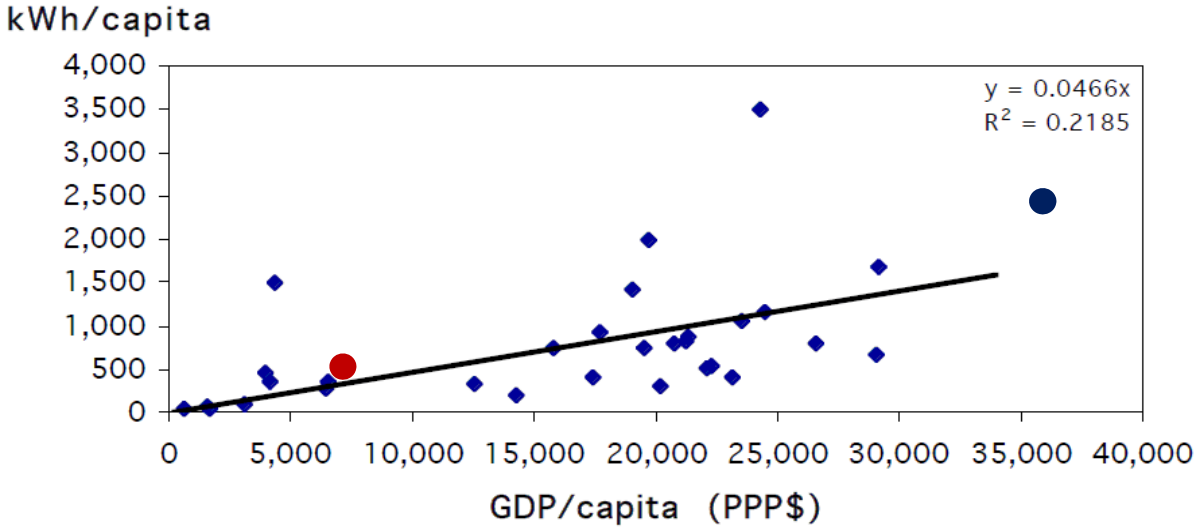


Energy saving

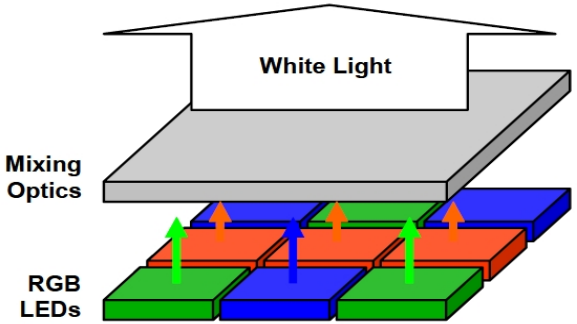
- 2,500 kWh = CDN $ 350 saving at 50%
  CDN $ 5 billions per year for Canada
- 500 kWh = RMB $ 250 saving at 50%
  RMB $ 150 billions per year for China

~ 25,000 hours

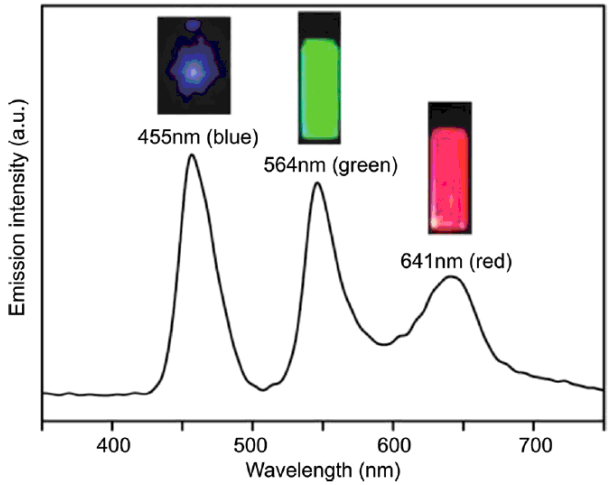
Adoption of LEDs for lighting ➔ more than 50% direct saving

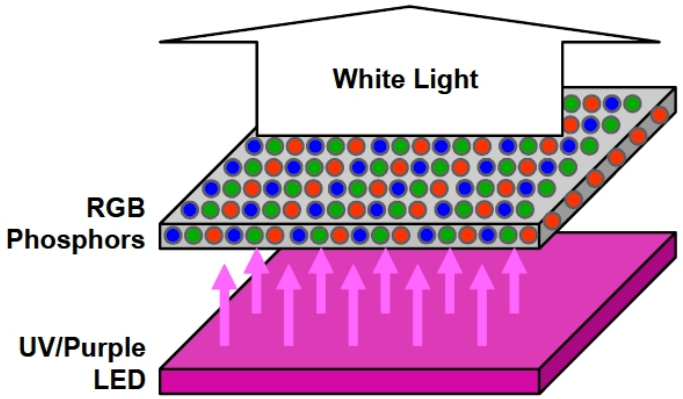


LED methods for white light



Conventional method:
color mixing → displays



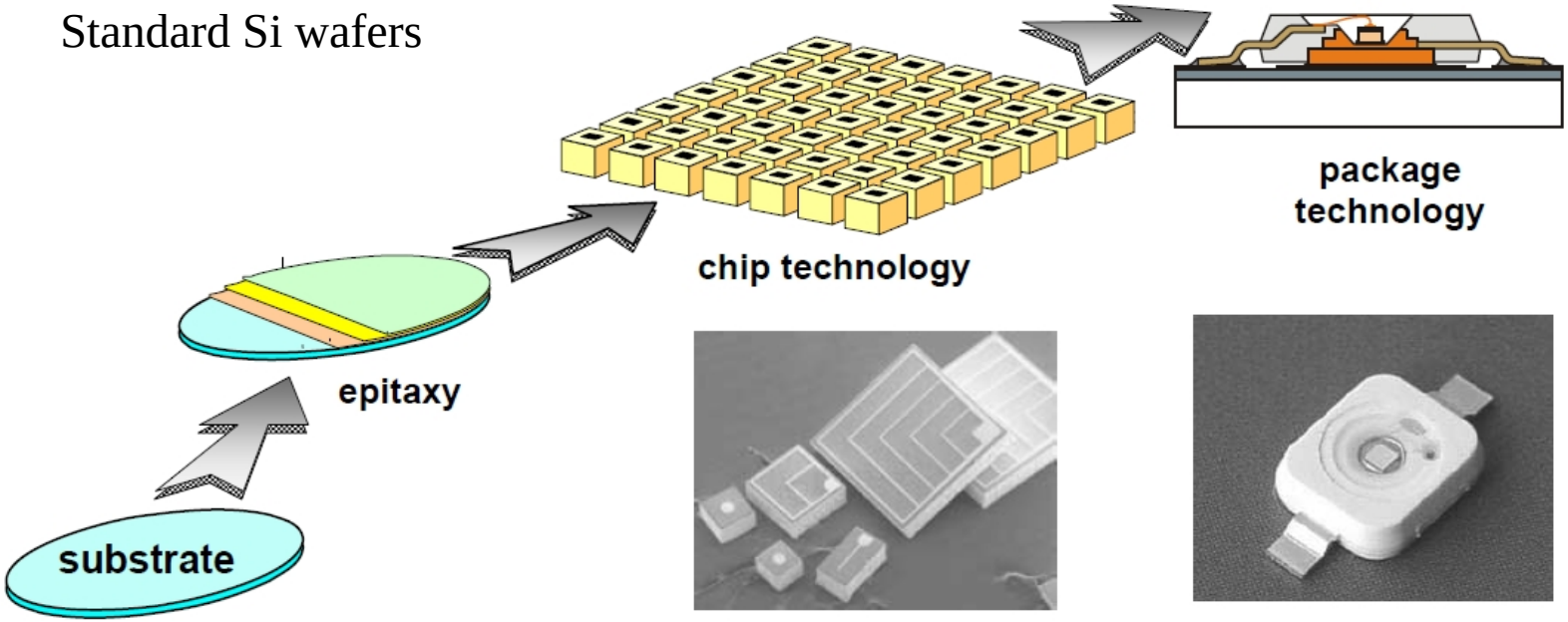


Phosphor conversion: **down conversion** → lighting

Advanced methods for white light ?

Main steps for LED fabrication – Inorganic LEDs

Standard Si wafers



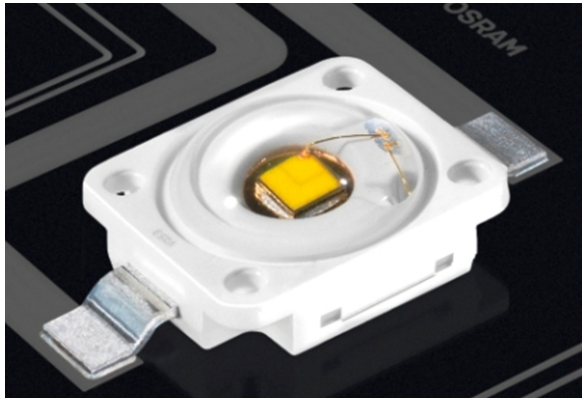
Our R&D will concentrate on the development of epitaxy of nano structures for light emission.

Simplified methods for epitaxy.

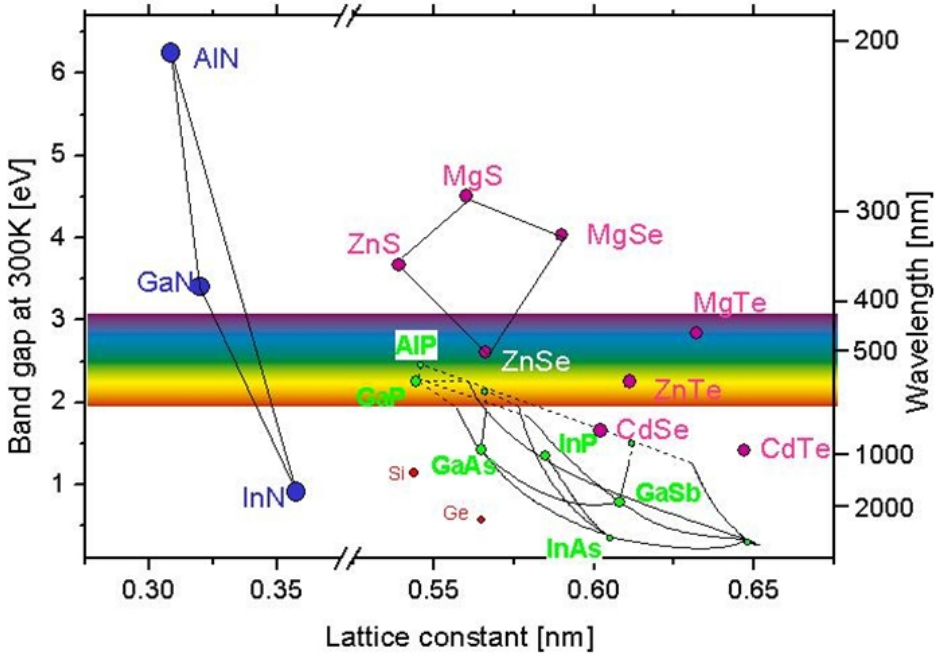
Main materials for LEDs

[1] GaAs – GaP
[2] InN – GaN
[3] Organic: small molecules, polymers

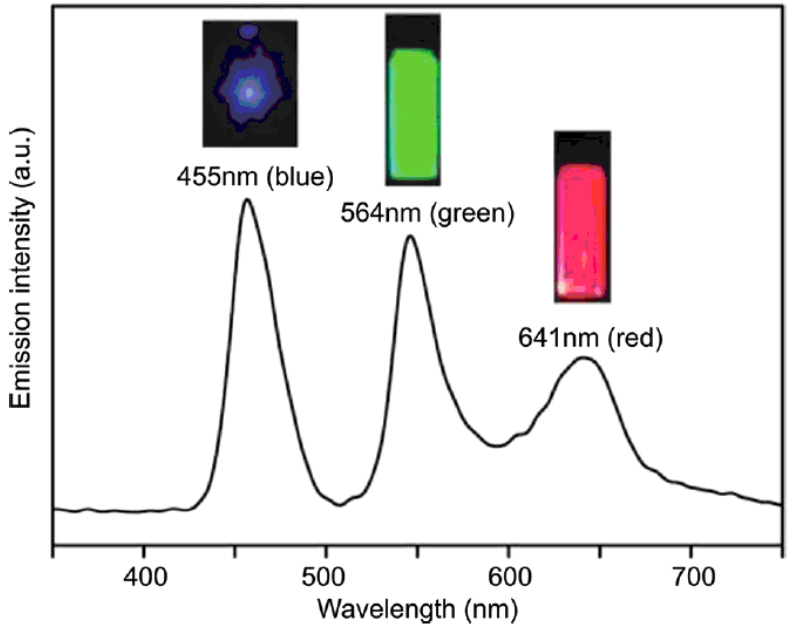
OSRAM LED



Color mixing: SC



Down conversion: phosphors

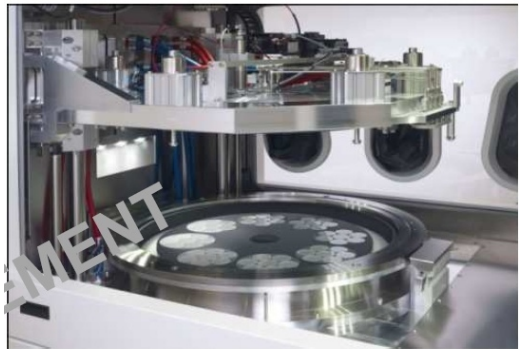


[2] Epitaxial Growth and Processing Systems:

MBE: Riber, Veeco

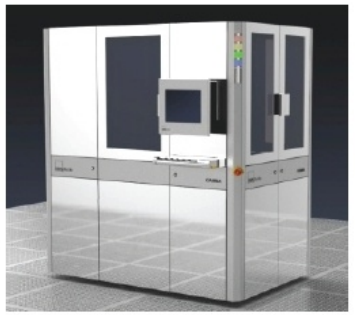
MOCVD: Veeco, Aixtron, Taiyo Nippon Sanso

There are 142 LED fabs in operation worldwide in 2012.



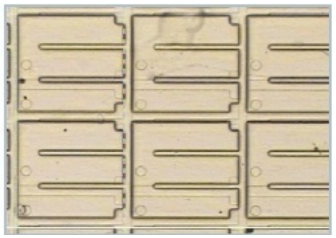
Aixtron G5HT 2" x 56 configuration

Veeco Maxbright Cluster tools: 2 to 4 reactors for high capacity. thr

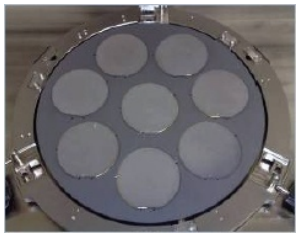


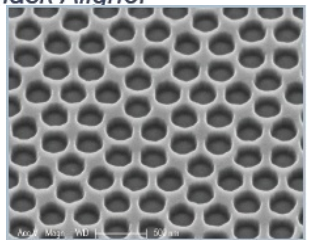
Gamma Coater/Developer

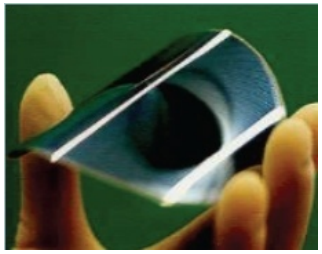
MA200Compact Mask Aligner



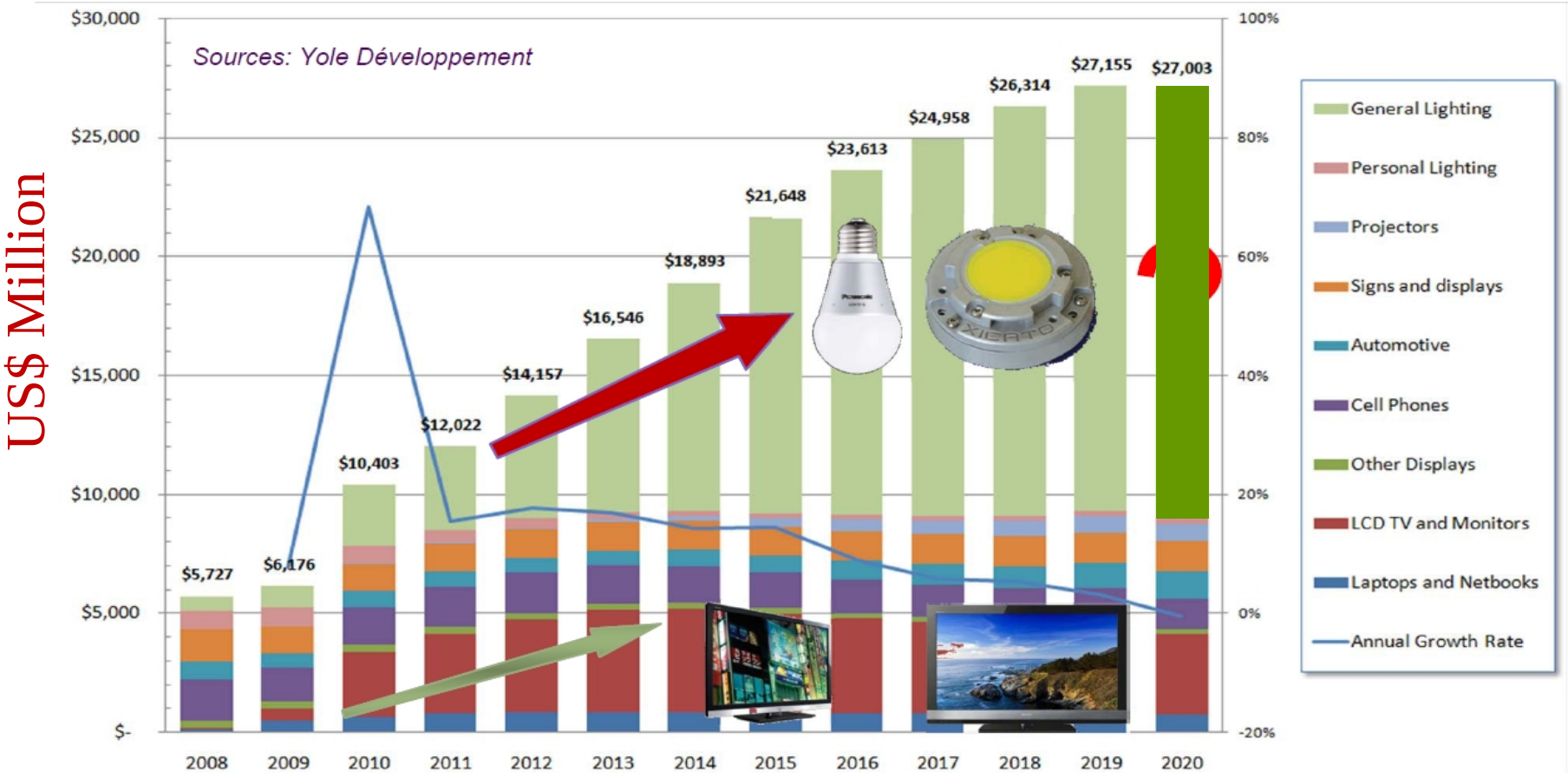
SB6/8e Wafer Bonder







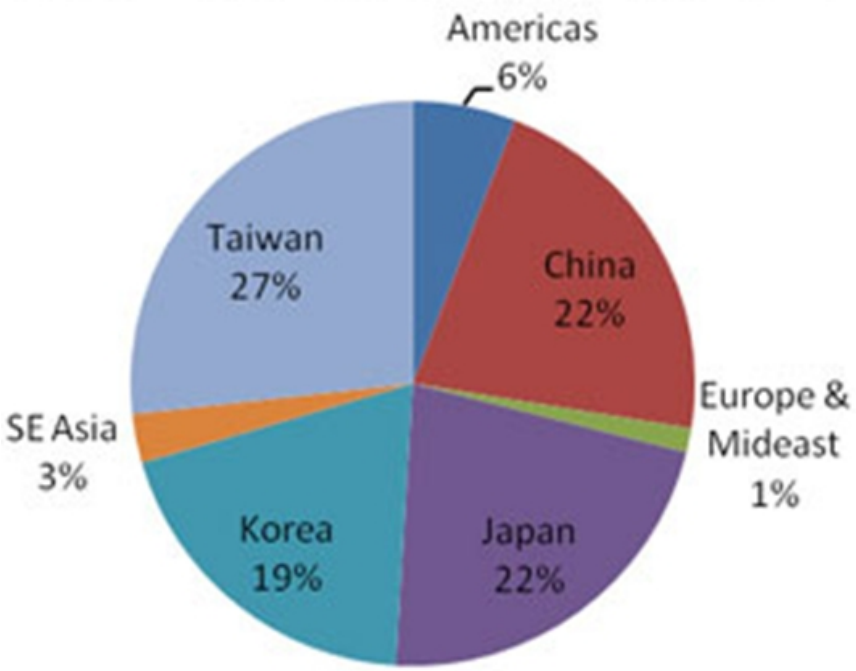
Opportunities and trends for LED s



Yole Development

Market of LEDs for lighting will exceed $15B in 2017

Current main manufacturers of LEDs



Source: SEMI Opto/LED Fab Forecast May 2011

Packaged LED sales: Top is Nichia of Japan, the list also contains 2 other Japanese companies (Sharp, **Toyoda Gosei**) as well as 3 Korean suppliers (Samsung LED, Seoul Semiconductor and LG Innotek). The USA is represented by Philips Lumileds and Cree, while Germany and Taiwan have one representative each (Osram Opto and Everlight, respectively).

Top 10 LED suppliers for 2011

1 Nichia

2 Samsung LED

3 Osram Opto Semiconductors

4 LG Innotek

5 Seoul Semiconductor

6 Cree

6 Philips Lumileds

7 Sharp

8 TG

9 Everlight

Revenue includes packaged LED sales only.

China is expected to become a major player of LEDs

China make twelfth five-year plan for LED industry development 2011-15

In China, LED chip makers planed to buy 1,400 MOCVD systems, have purchased 400 and installed 350 sets in 2011.

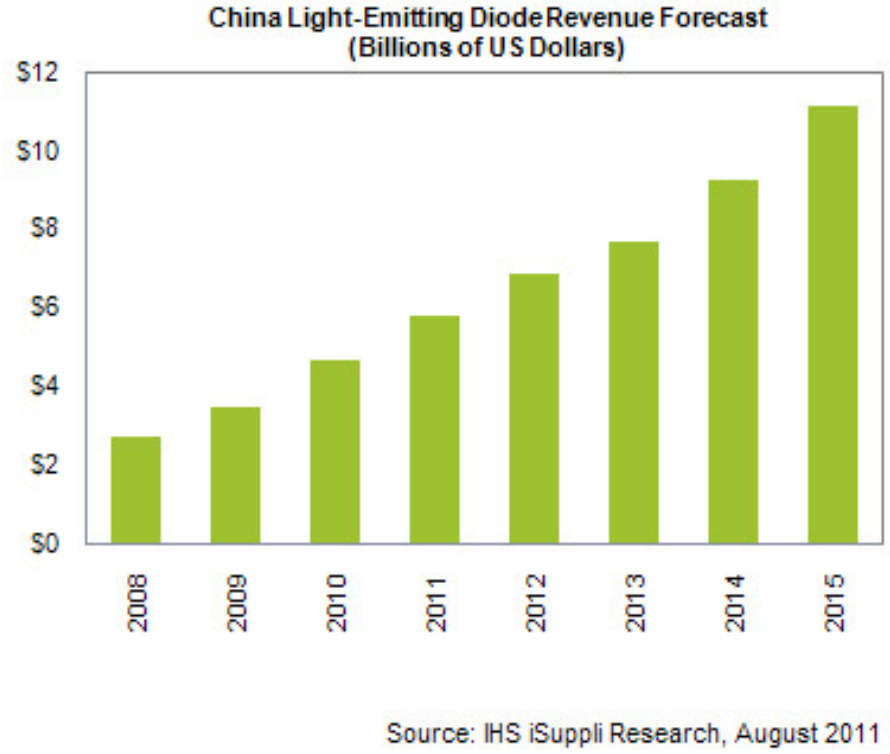
According to reports, the governments in China subsidize US$1.2-1.5 million of each MOCVD system, and have attracted many LED chip makers from Taiwan and the US to set up facilities.

Examples:

→ Sanan Optoelectronics invested 12 billion yuan to expand upstream and planed to procure around 100 MOCVD sets.
→ Tsinghua Tongfang had planed to invest 3 billion yuan in LED chip production and to become China's largest and a world top-three supplier.
→ Silan Microelectronics would raise 600 million yuan for expanding high-brightness LED chips producing.
→ In addition, Elec-Tech International Co Ltd has made significant investment on LEDs.

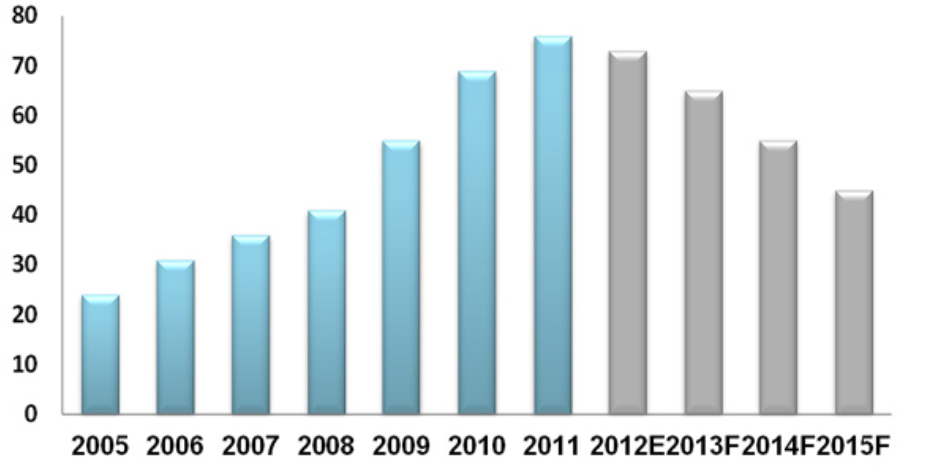
China's LED Industry Lights Up to Nearly $6 Billion in 2011

August 18, 2011



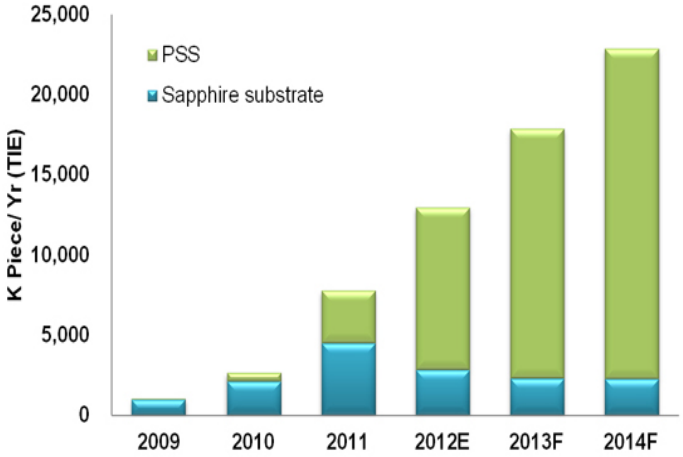
SEMI Opto/LED Fab Forecast reported a global LED capacity of 4.39 million wafers per month (in 2-inch equivalents) in 2010 and was 6.46 million wafers per month (in 2-inch equivalents) in 2011. [80 millions per year, 40 2 inch pieces/3 hrs]

Epitaxial and Chip Fabs for LEDs in China



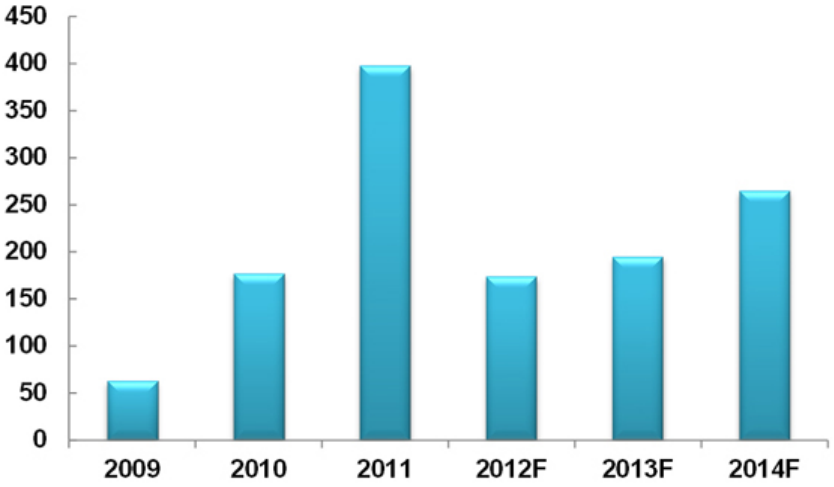
Source:; SEMI China 2012

PSS and plain sapphire substrate demand in China



Source:; SEMI China 2012

New MOCVD for LEDs in China



Source:; SEMI China 2012

Patterned Sapphire Substrate (PSS) is used in GaN epitaxial processing to achieve high brightness. Based on SEMI China statistics, overall PSS penetration in China's LED epitaxial Fabs is close to 80 percent.

April 15, 2010 08:02 AM Eastern Time

LED Tunnel Lighting Yields 60% Energy Savings for Chinese Highway Project

Developed by Xian Liming with Support from Future Lighting Solutions

MONTREAL--(BUSINESS WIRE)--LED-based tunnel lighting for two new highway tunnels in central China is saving up to 60% in energy consumption and related costs over fixtures built with traditional light sources. Utilizing LUXEON Rebel LEDs from Philips Lumileds, the 3,900 fixtures involved in the project were developed by Xi'an Liming Electronic Co.

LEDs Light Up the Largest Municipal Street Lighting Project in China

Posted on July 3, 2012 by Joshua S Hill

More than 1.9 million LED lights were recently installed in over 20,000 street lights the Beibei district of Chongqing, China in the country's largest municipal intelligent lighting control project, which includes nearly 16 miles of highway, 119 streets, and one tunnel.

Officials estimate the installation will result in annual maintenance and electricity savings of more than RMB 19.5 million (approximately USD 3 million) and 17.6 million kWh.

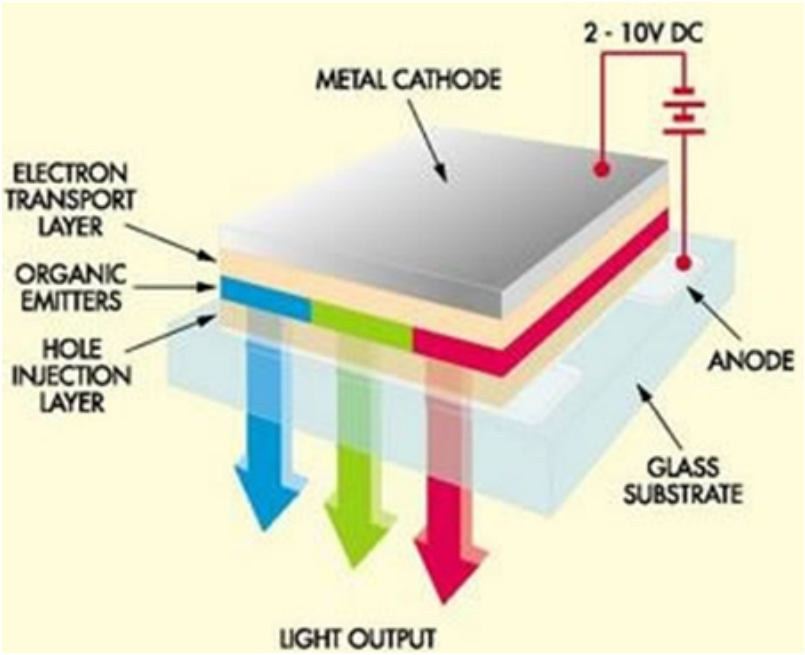
China's First Major Highway LED Lighting Project

Helping to further drive the LED lighting revolution, China recently completed its largest highway lighting upgrade with more than 10,000 street lights featuring more than a million High Efficiency White (HEW) LEDs. The Shenzhen highway project includes nearly 120 km of roadways, with LED fixtures installed along one tunnel and four highways.

Kingsun installed 270 W and 300 W RL2R Apollo LED luminaires alongside the highways, including three traffic lanes and an emergency lane in each direction. The installation was designed to average more than 20 lux, the national standard for main roads illumination.

Source: ***Cree, Inc.***

Organic Light Emitting Diodes: OLEDs

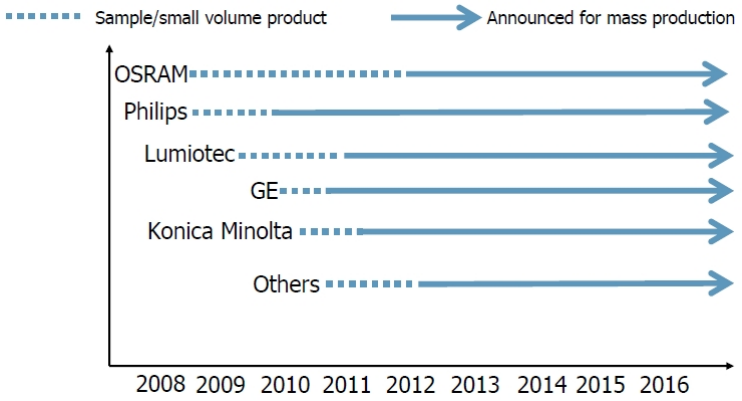


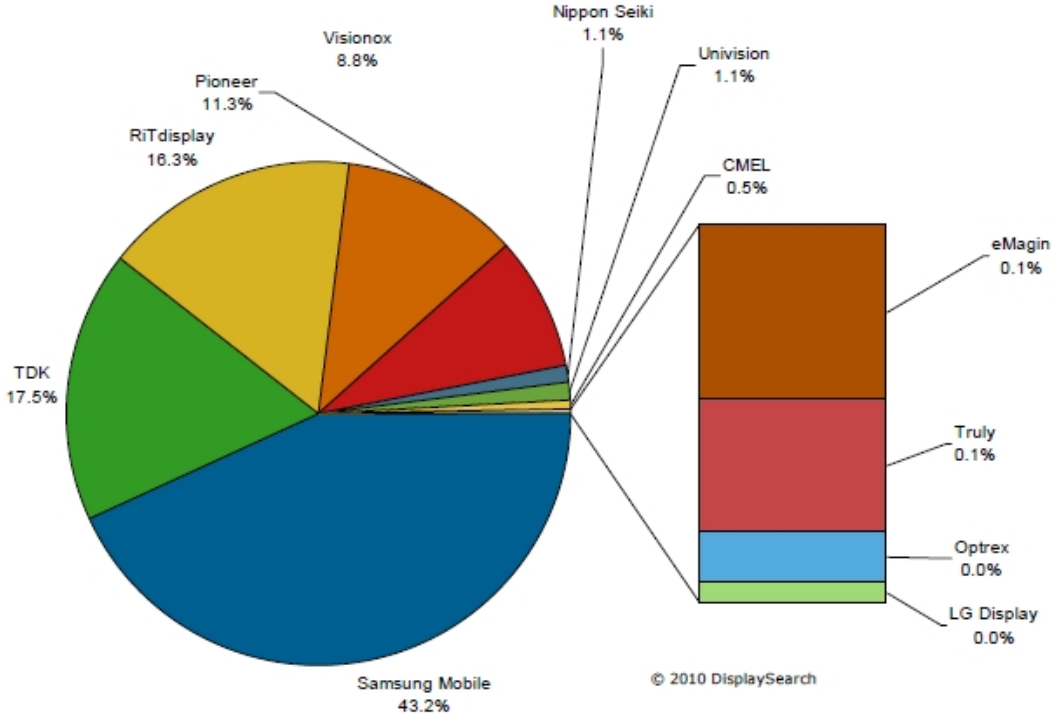
Traffic light and street light

Different generations of LCD technology. Dimensions are in mm.

Gen	1	2	3	4	5	5.5	6	7	8	9	10
Short	300	370	550	730	1100	1300	1500	1870	2200	2500	2880
Long	400	470	650	920	1300	1500	1850	2200	2500	2800	3130

Ultra Thin Displays





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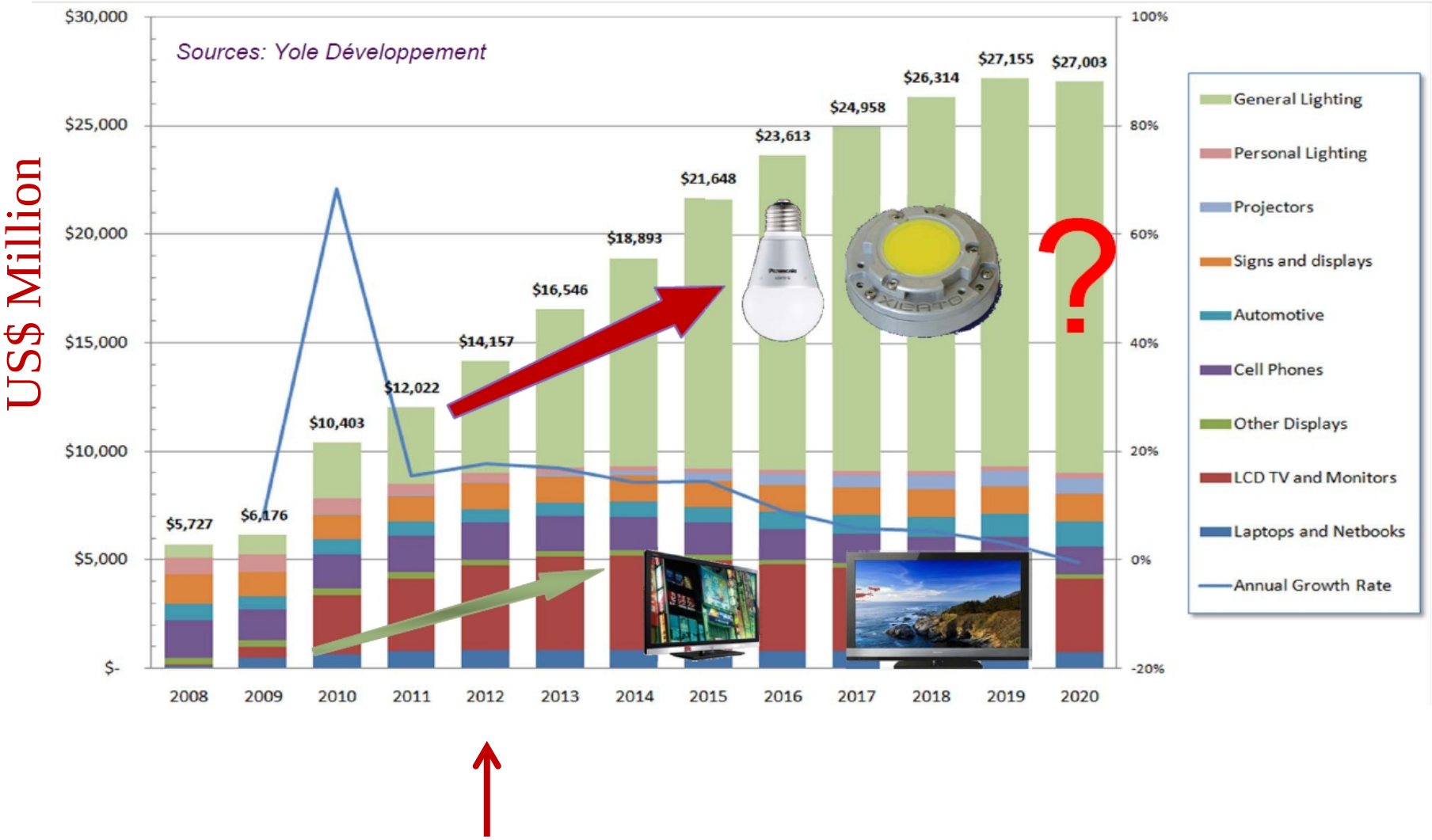

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Discussion