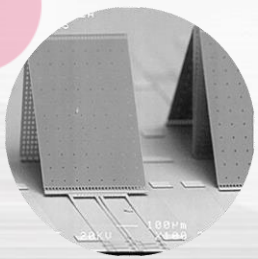
Innovative MEMS, Opto and Nano Technologies in LG Electronics



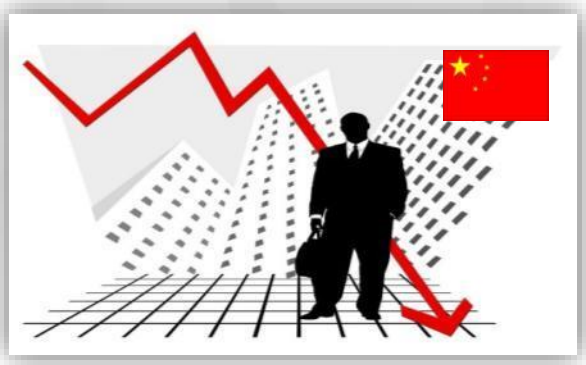
VP Jeongsoo Lee
Materials & Devices Advanced Research Institute
LG Electronics

Contents

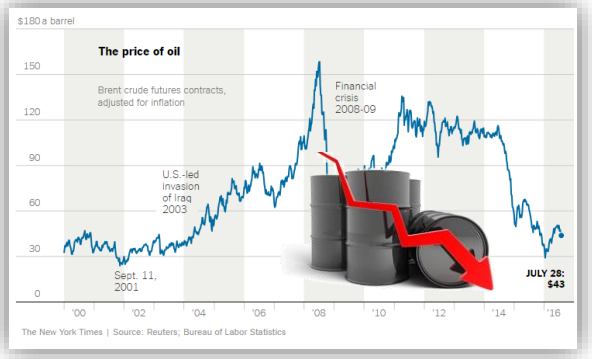
I. IT Industry Trends

Uncertainty of the Global Economy

- Fall of consumption due to Demographic Cliff (`18)
- Strong Dollar leads to Increase in US interest rate



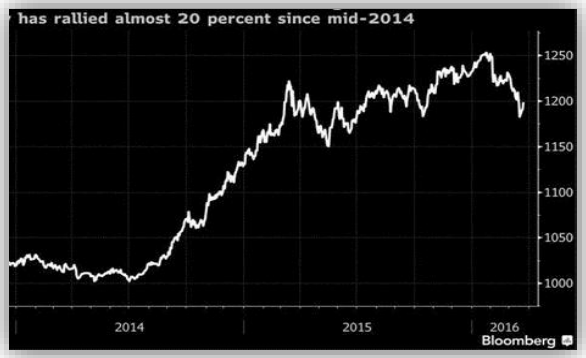
Collapse of China's Stock Prices



Low Oil Price Era

Fall of Consumption

(Bloomberg Dollar Spot Index)



Strong US Dollar

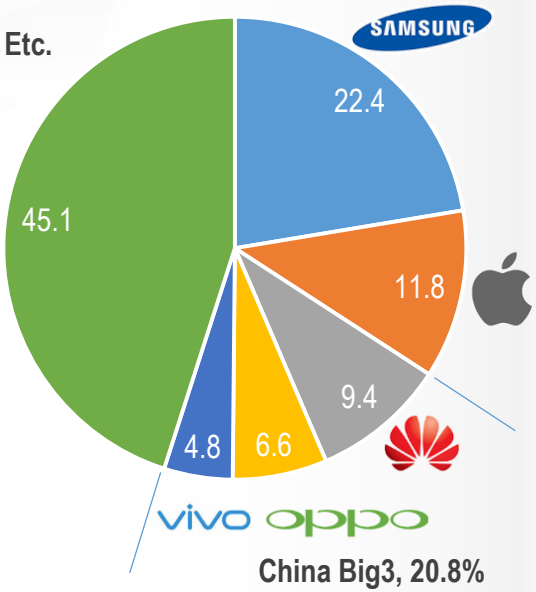
The Rise and Fall of IT Companies

Fall of 'TGIF'

Rise of 'FANG'

Chinese Advance

Smart Phone

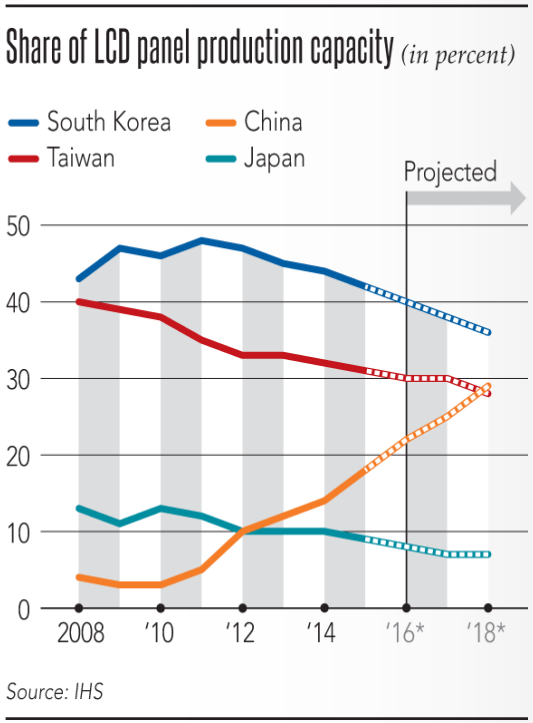


China Big3, 20.8%

Global Market Share(`16.2Q)

Source: Statista

LCD Panel



Source: IHS

M&A

GE APPLIANCES
a Haier company

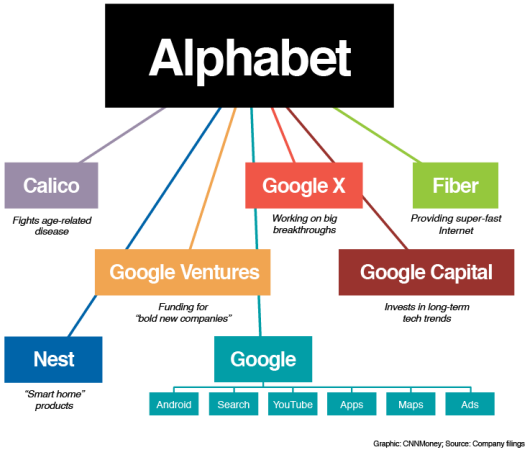
China's Haier to Buy GE Appliance Business for $5.4 Billion(`16)

Andy Kiersz/Business Insider

New Challenges

Blue Origin
(Jeff Bezos, Amazon Founder)

Space X
(Elon Musk, Teslar Founder)



Alphabet(Google)

Aquila
(First Solar Powered-Drone for Internet, Facebook)

Hyperloop
(High Speed Transportion over 700mph, Elon Musk)

II. LGE's Biz. Strategy

Business Units

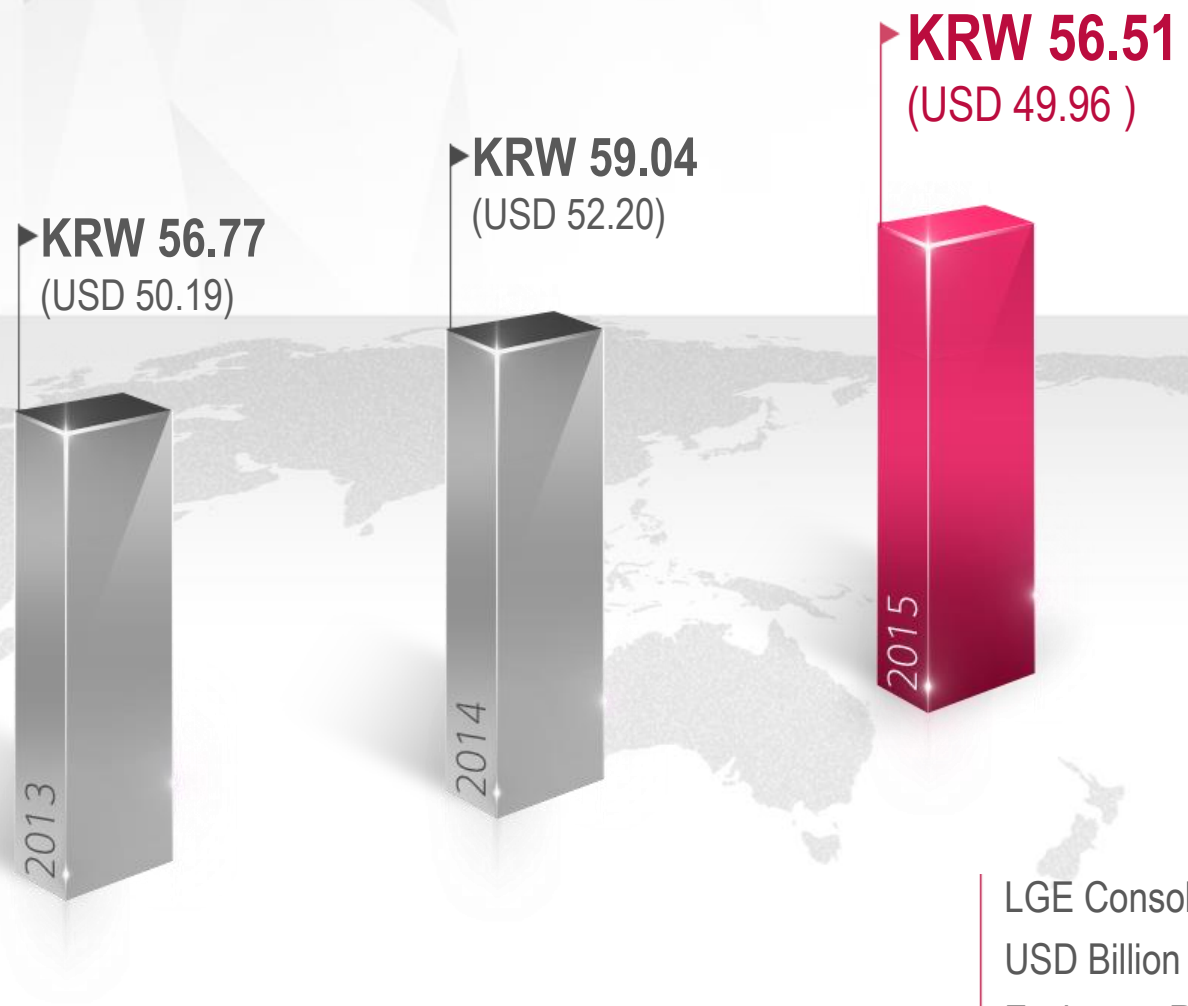
Home
Entertainment

Mobile
Communications

Home Appliance
& Air Solution

Vehicle
Components

Global Sales



LGE Consolidated Basis, IFRS
USD Billion (KRW Trillion)
Exchange Rate: KRW 1,131 per USD

Business Strategy

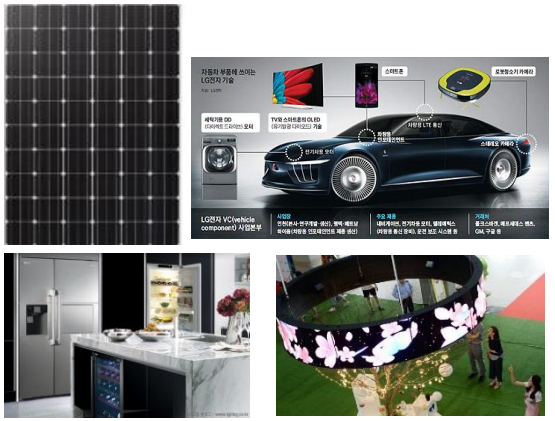
Press Release

LG ELECTRONICS ANNOUNCES KEY LEADERSHIP CHANGES TO ENHANCE FLEXIBILITY AND DECISION-MAKING FOR 2016

New Senior Leadership Structure to Strengthen Company's Position in Diverse Business Environment

SEOUL, Nov. 26, 2015 — LG Electronics (LG) today ... **Complementing LG's ongoing leadership in televisions, mobile devices and appliances, high-growth areas such as Automotive components, Energy, IT and B2B are expected to drive more of LG's growth going forward.** ...Executive Vice President Brian Na will be responsible for LG's Overseas Sales and Marketing, overseeing 47 LG sales subsidiaries worldwide.

B2C



B2B

Solar Energy

- Continuous Technology Leadership and Investment in the Photovoltaics Industry

✓ Awarded the "Intersolar Award" with the new "NEON2 Bifacial Module" at Intersolar 2016, the world's leading exhibition for the solar industry

✓ Signed MOU for the investment of new solar panel production lines (Jan 2016, Gumi, Korea)
- Build 6 new lines by first half of 2018 (450million USD), in total 14 lines

Investment of new lines

Intersolar Award

Vehicle Components

Bolt EV to be Developed through Strategic Partnership Between GM and LG (`15.10)

Volkswagen launched electric microbus BUDD-e at CES 2016 with LGE (`16.1)

Agreed to supply Fiat & Mercedes Benz with Wireless Charger Module (`16.3)

GM Chevrolet Bolt EV

POWER ELECTRONICS
- ON-BOARD CHARGER
- HIGH-POWER DISTRIBUTION MODULE
- ACCESSORY POWER MODULE
- POWER LINE COMMUNICATION MODULE

DISPLAYS
- INSTRUMENT CLUSTER
- INFOTAINMENT SYSTEM

HVAC
- ELECTRIC CLIMATE CONTROL SYSTEM COMPRESSOR

MOTOR
- ELECTRIC DRIVE MOTOR
- POWER INVERTER MODULE

BATTERY
- BATTERY PACK
- BATTERY HEATER

<Bolt EV @CES 2016>

<CES Keynote Speech>


<Solar Cell on rooftop>


<IoT Infortatinment>

III. MEMS, Opto, Nano Tech. in LGE

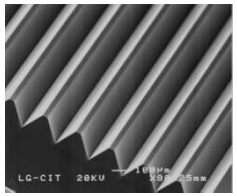
Introduction to LGE MDARI[1)]

History

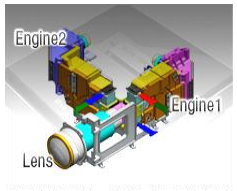
- 1987 Established as Goldstar Central Research Center
- 1990 Korea's First TV TFT-LCD [LG Display]
- 1996 Korea's First Blue LED [LG Innotek]
- 1998 Korea's First Full Color 4" OLED [LG Display]
- 1998 Korea's First MEMS[2)]
- 2008 Crystalline Solar Cell [LG Electronics]
- 2015~ New Business Items

R&D Competency

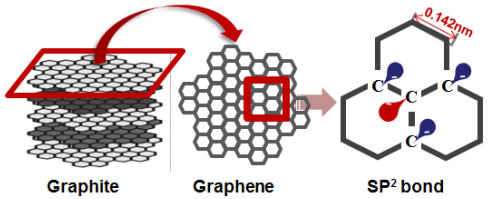
- **Semiconductor Design & Process**
  - LED, SolarCells, MEMS



- **Optics**
  - Projection, Lighting



- **Nano Materials**
  - Phosphors, Graphene, etc



1) Materials & Devices Advanced Research Institute 2) Micro Electro Mechanical System

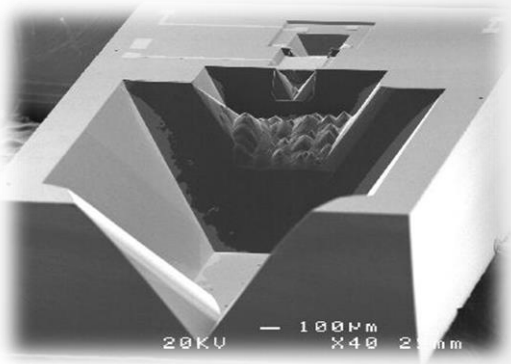
MEMS

Recent R&D Achievements

- Developed Mobile/ Home Appliance sensors, LED packages, Laser Scanning Technologies based on MEMS

1992~1996

Foundation



1) Wafer Level Package, World's First

1997~2005

Sensors

Air conditioner IR Sensor (`97)

Microwave Auto-Cooking Sensor (`00)

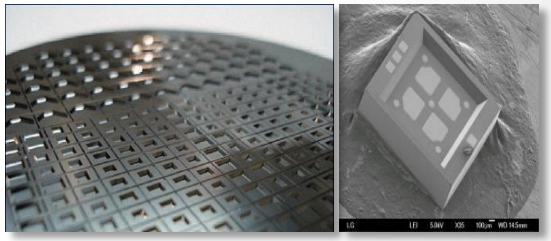
Alcohol Sensor (`03)

Humidity Sensor (`04~`05)

2006~

Scanner, LED Package

Laser Scanner for Pico Projector (`06~)



WLP[1] for LED (`07)

Opto_Projection

- Developed Laser TV and LED Mini Beam TV using Projection Technology

Laser TV

- World's Largest Wall-mount TV(`13)

Mini Beam TV

- World's First Full HD LED TV(`13)

POPULAR SCIENCE THE FUTURE NOW CES 2013

reddot design award

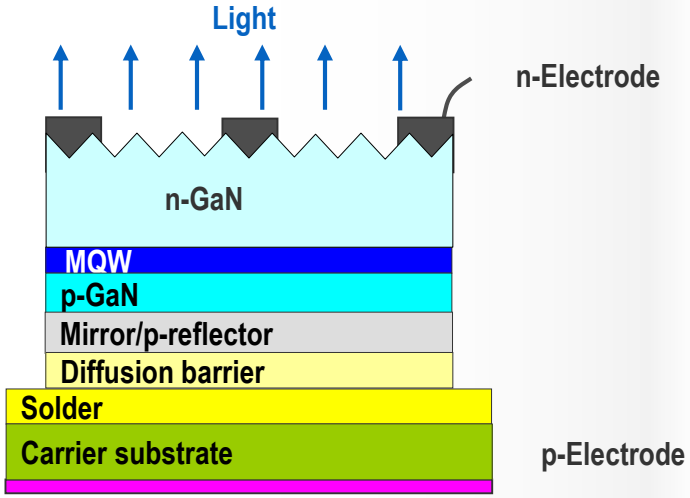
Opto_LED/ Solar

Recent R&D Achievements

- Secured fundamental LED and Solar Cell technologies in the field of Optoelectronics

Blue LED

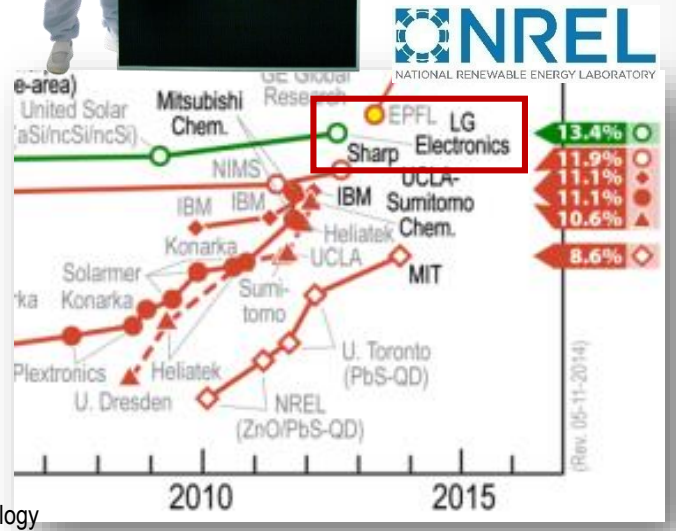
Devloped Korea's First Blue LED (`96)



Patented Vertical LED technology (`08)

Silicon Thin Film Solar Cells

Silicon Thin Film Cell/ Module World Record Efficiency (`12)
- Cell 13.4%/(NREL[1]) , Module10.9%(AIST[2])



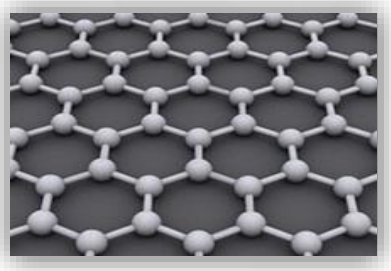
1) National Renewable Energy Laboratory, 2) National Institute of Advanced Industrial Science and Technology

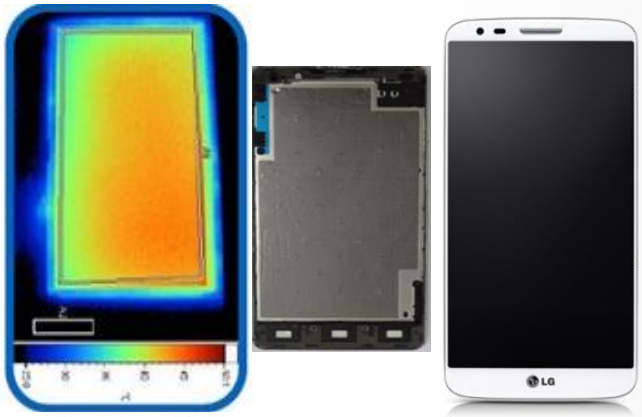
Nano Materials

Recent R&D Achievements

- Developed Graphene Heat Dissipation Sheet for mobile applications, and Yellow Phosphors with New Composition for Camera Flash and Street Lamps

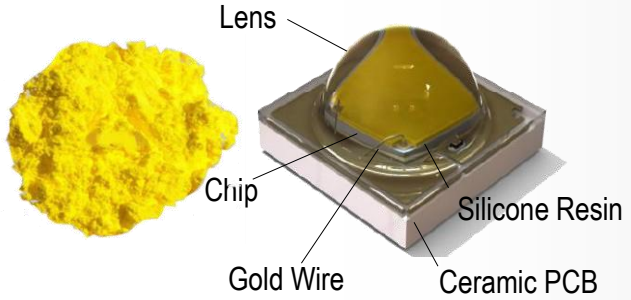
Graphene





Heat Dissipation Sheet For LG G2(`13)

Phosphor



Mobile Camera Flash(`15)

Street Lamps(`15)

Vehicle Components

R&D Approach for New Biz.

- Large Screen AR[1] HUD[2] : Display on CES 2016 (`16.1)
- Head Lamp/ Rear Lamp : Next Generation Vehicle Lamp (`16~)

Head up Display

Head Lamp

Rear Lamp

Opto & Nano

- Laser/ LED Optics
- Nano Phosphors

1) Augmented Reality 2) Head-Up Display

Signage/ Commerical Displays

R&D Approach for New Biz.

- MEMS[1] Technology applied in Digital Signage
- Researching Disruptive technology for Advanced Signage

New Concept Display

Future Signage

MEMS & Opto

- MEMS Scanner
- Laser Optics

Opto & Nano

- LEDs
- CVD Graphene

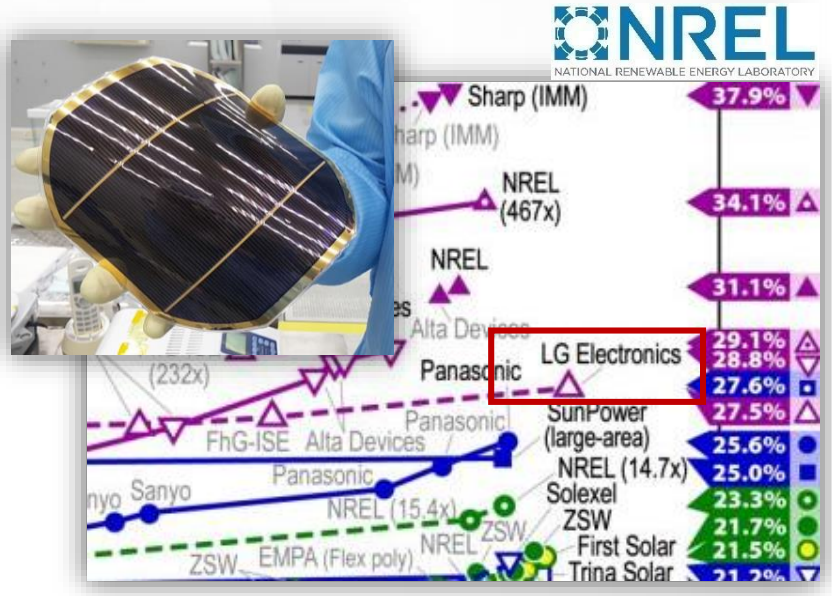
1) Micro Electro Mechanical System

Energy/ Environment

R&D Approach for New Biz.

- World Best Cell Efficiencies on Single-junction GaAs[1] Solar Cells (27.5%, `15, NREL[2])
- Semi-permanent Filter System on LG SIGNATURE Air Purifier (`16.1)

GaAs Solarcells



Premium Air Purifier

LG SIGNATURE

Semi-permanent Air Filter

Opto & Nano

1) Gallium Arsenide 2) National Renewable Energy Laboratory

Conclusion

- *MEMS, Opto and Nano Technologies are crucial for success in Automotive, Energy and B2B sectors, which are new business domains of LG Electronics*

- *To gain competitive edge, LG Electronics are looking for collaboration partners for Open Innovation while also focusing on in-house R&D*

For Up-To-Date News About LG

For LG's Corporate Mobile Website