Светодиоды для дисплейных применений: технологии, рынок

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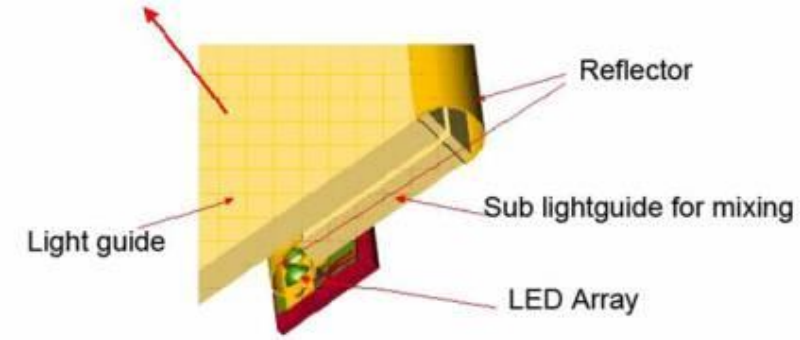
План

- Технологии дисплейных устройств со светодиодными подсветками
- Рынок светодиодов по применениям (дисплеи)
  - Ø мобильные устройства,
  - Ø экраны,
  - Ø автомобильные панели,
- Устройства на основе органических светодиодов (OLED)

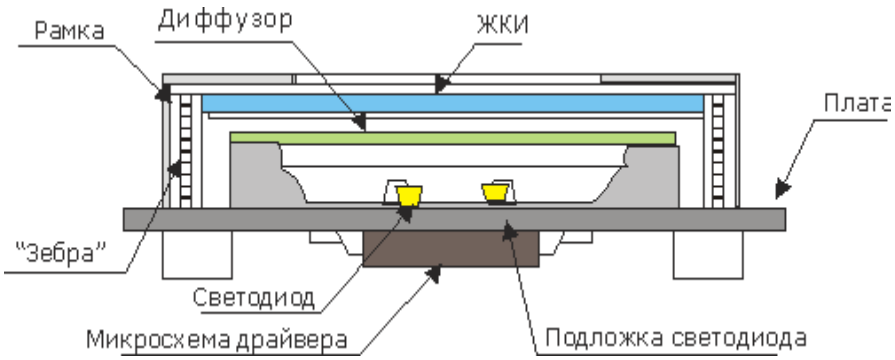
Технологии дисплейных устройств со светодиодными подсветками

Светодиодная подсветка в ЖК



Решающим фактором должен стать переход от подсветки прямого типа на торцевой тип благодаря изменению конструкции и, соответственно, удешевлению второй, что будет окончательно способствовать вытеснению люминесцентных ламп с холодным катодом (CCFL) из систем подсветки .

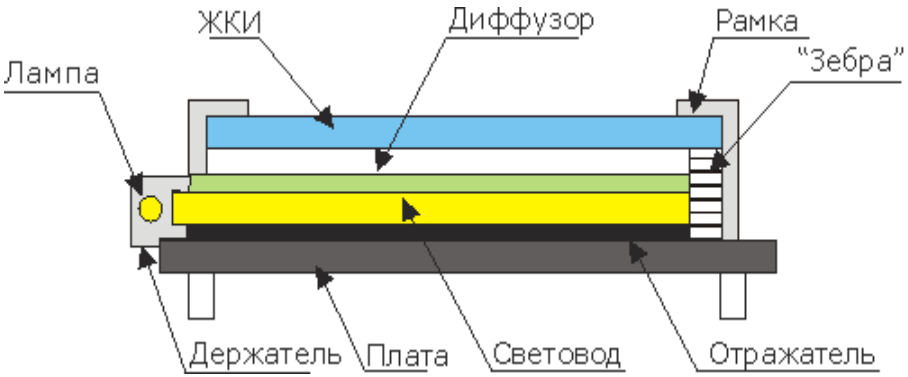
LED (Light Emitted Diode) – светодиодная подсветка



Преимущества подсветки LED:

- низкое энергопотребление,
- долгий срок жизни (до 100000 часов),
- большой выбор цветов.

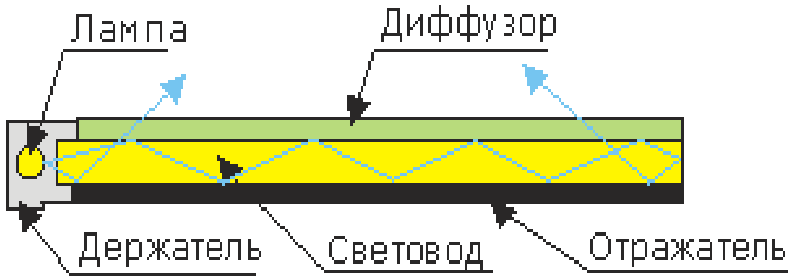
CCFL (Could Cathode Fluorescent Lamp) – люминесцентная лампа

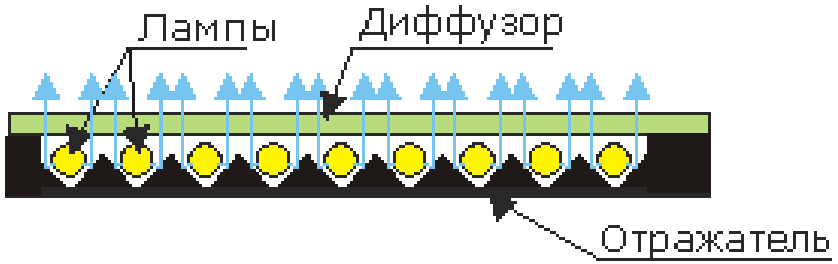


Преимущества подсветки CCFL:

- сравнительно долгий срок жизни (около 15000 часов),
- высокая яркость,
- низкое тепловыделение.

Разница между боковой и фронтальной подсветкой





Из конструктива подсветки следуют очевидные выводы:

- боковая подсветка менее равномерна (чем ближе к лампе, тем ярче),
- нагрев при боковой подсветке намного меньше (меньше источников нагрева),
- при боковой подсветке много меньше энергопотребление (меньше основных потребителей),
- боковая подсветка существенно дешевле фронтальной,
- яркость фронтальной подсветки выше и равномерно распределена.

Local dimming

Преимущества подсветок на основе светодиодов по сравнению с подсветками на основе люминесцентных ламп:

- яркость,
- цветопередача,
- размер,
- токопотребление,
- стоимость

Один светодиод обеспечивает **равномерную подсветку меньшего числа пикселей**, что позволяет создавать **эффект локального затемнения (local dimming)**.

С local dimming

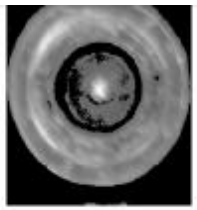
Без local dimming

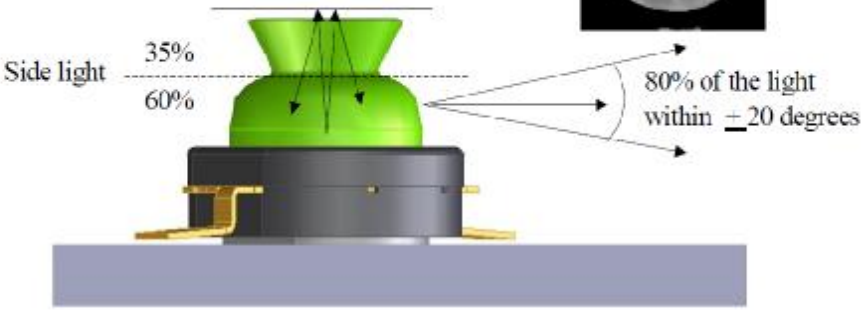
Ø В ЖК телевизорах **большого размера** используется так называемая **прямая подсветка (direct-light)** с матричным расположением светодиодов за ЖК дисплеем.

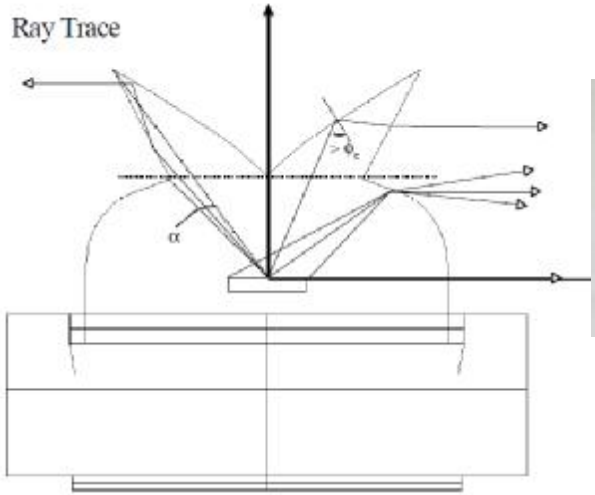
Ø В панелях **меньшего размера** чаще используется **торцевая (edge) подсветка**.

Светодиоды для фронтальной подсветки ЖКД

~5-8% of the light emitted from LED will be reflected by the diverter preventing color spots on the screen







Светодиоды в пикопроекторе

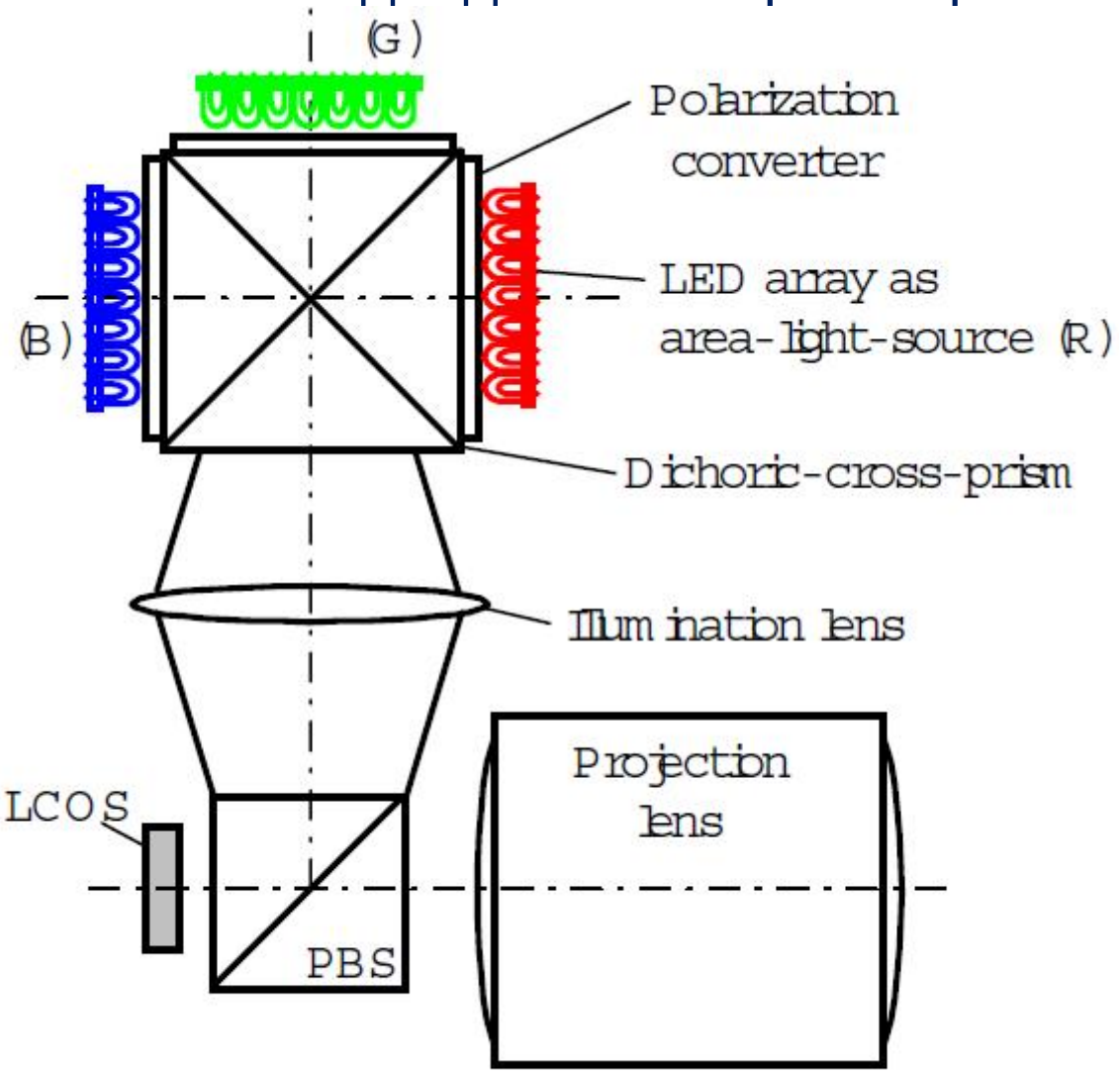
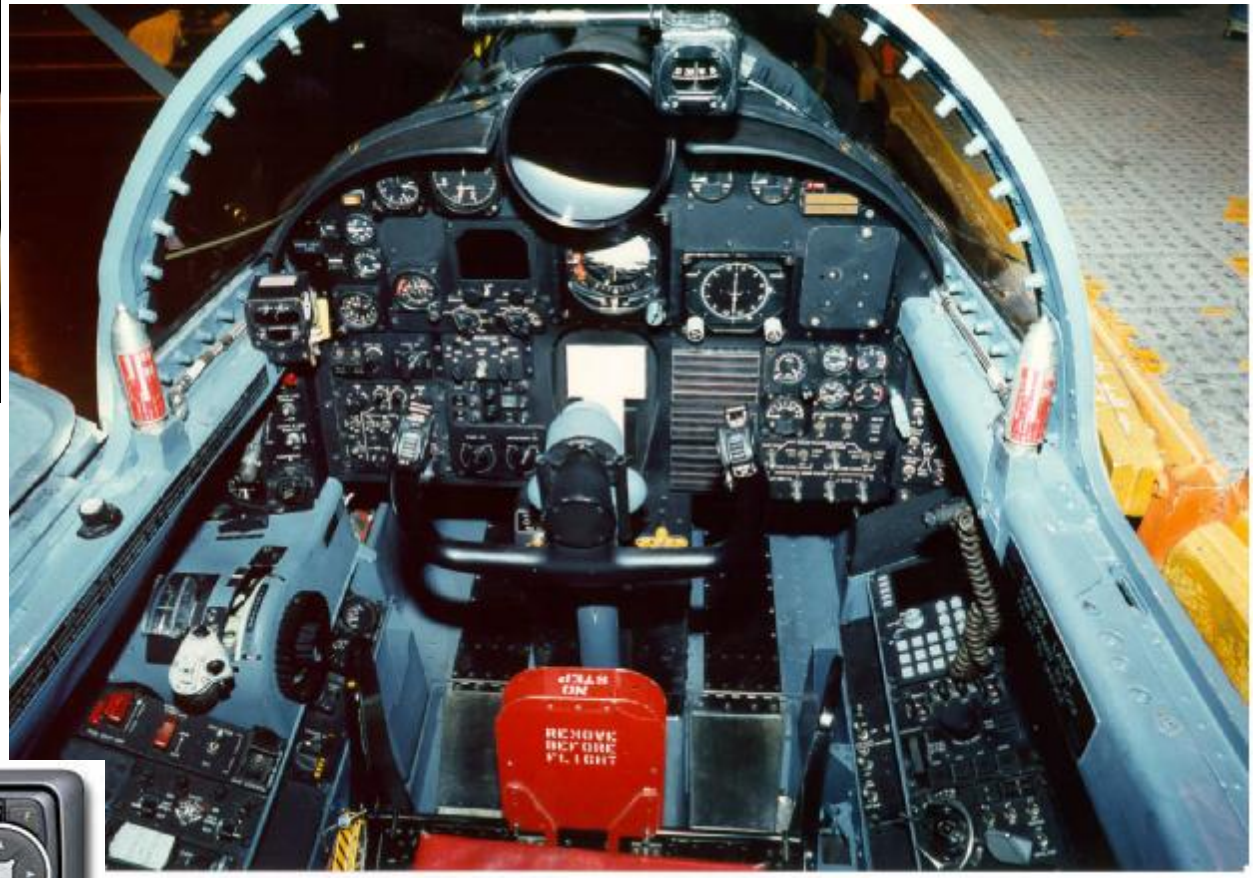


Fig. 3 Schematic structure of the LED projector.

Светодиоды в автомобилях и самолетах



Рынок светодиодов по применениям

Table 1: LED Demand by Application (Millions of Units)

Application	2007	2008	2009	2010	2011	2012
Backlight for Notebook PC	127	532	3503	6,230	8,193	8,873
Backlight for Desktop Monitor	0	5	145	585	1,032	1,789
Backlight for LCD TV	16	150	1,461	4,890	10,525	15,102
Backlight for Large Others (includes Industrial)	4	189	475	701	879	1,114
Backlight for Small/Medium	6,662	7,253	6,046	6,768	7,059	7,244
Sub-total for Backlights	6,809	8,129	11,630	19,174	27,688	34,122
Active Outdoor Display	8,755	10,947	11,584	12,941	16,809	24,481
Signal	1,512	2,125	2,582	2,925	3,302	4,991
Automotive	3,665	4,587	5,371	6,213	7,582	10,681
Освещение	3,606	4,755	6,148	7,919	10,679	14,882
Others	44,314	40,245	38,491	46,716	51,504	77,854

Подсветки - 20% рынка светодиодов

- Display LEDs, including 24 billion for active outdoor display and 34 billion for LCD backlights, will have a 34.7% share of the global 167 billion unit LED market in 2012, making display LEDs the largest market segment.
- Low-current LEDs will be the mainstream type used in large-area LCD backlights, due to cost, thermal management and luminance efficiency requirements.
- High-power LEDs, with a driving current higher than 350 mA (more than 1W), are not well-suited for LCD backlights due to thermal issues, and will mainly be used in general lighting applications that require high brightness.
- Leading LCD TV brands including Samsung, Philips, Sharp, Sony, Toshiba, Vizio and LG increase use of LED backlights

Доходы от продаж различных видов плоскопанельных дисплеев (в млрд. долл.)

Table 1: 2010-2012 Worldwide FPD Revenues by Technology

Master Technology	2010	2011	2012	2011 Y/Y Growth	2012 Y/Y Growth
TFT LCD	$105.9	$99.4	$107.7	-6%	8%
AMOLED	$1.2	$3.5	$6.5	183%	84%
PDP	$4.9	$4.4	$3.4	-11%	-23%
PMLCD	$1.7	$1.2	$0.9	-26%	-32%
CRT	$1.1	$0.7	$0.4	-35%	-38%
AMEPD	$0.7	$1.0	$0.4	43%	-58%
PMOLED	$0.3	$0.3	$0.3	5%	-2%
LCOS	$0.1	$0.1	$0.2	9%	6%
DLP	$0.2	$0.1	$0.1	-8%	-9%
VFD	$0.2	$0.1	$0.1	-19%	-16%
Total	$116	$111	$120	-5%	8%

Плазменные панели

ЭЛТ

AMEPD (**активно-матричные электрофоретические дисплеи**), для **монохромных** e-reader

ЖК-на-кремнии – ЖК микродисплеи

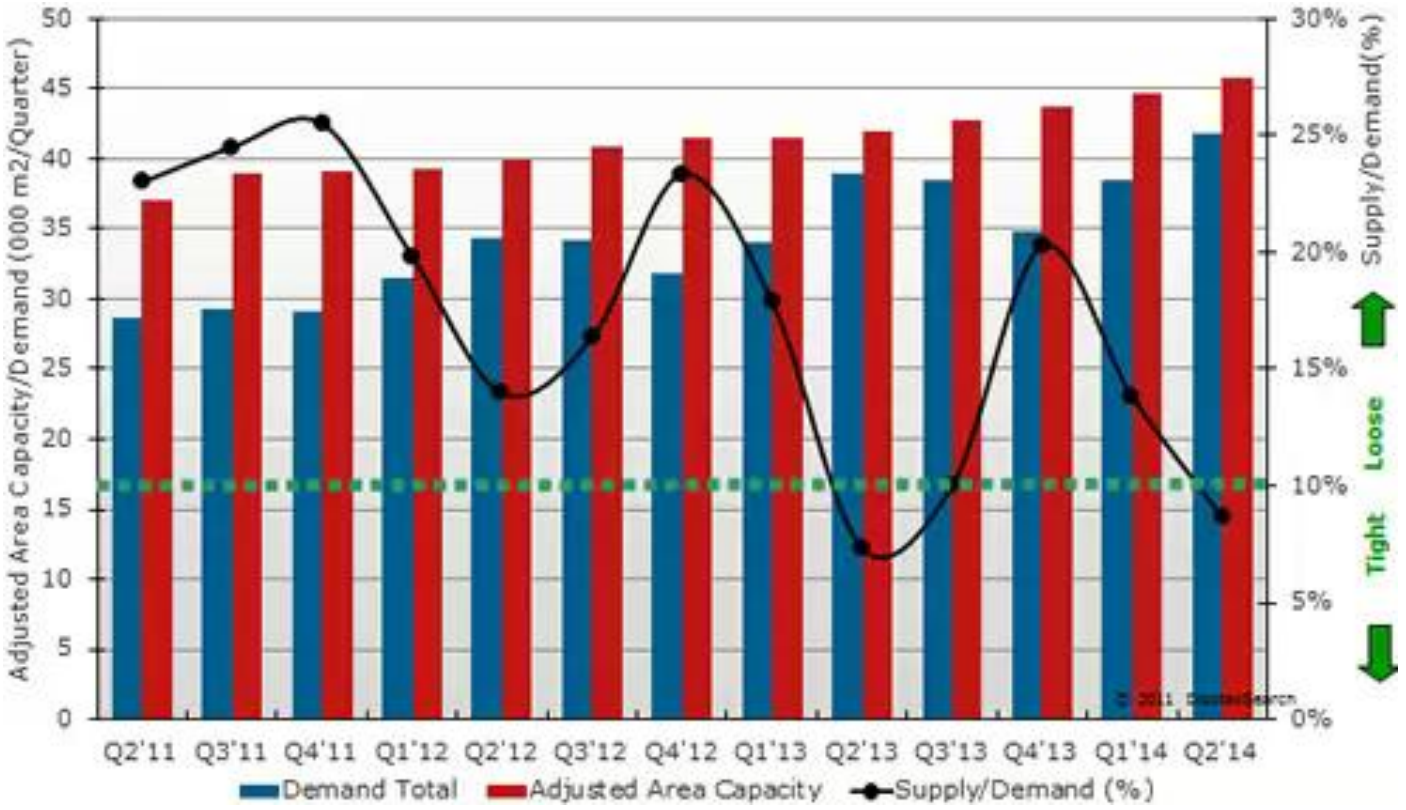
Цифровые проекторы

Вакуумно-люминесцентные дисплеи

\- +

Двигатели прогресса плоскопанельных дисплеев (ППД)

- increasing average sizes and shipments of LCD TVs,
- higher prices for high-resolution mobile displays for applications such as smart phones and tablet PCs,
- strong unit growth of tablet PCs,
- expansion of AMOLED shipments and applications,
- thin and light ultra-slim notebook PC panels,
- emerging 4K×2K LCD TVs,
- growth of demand from applications including
  - Ø games,
  - Ø car navigation systems,
  - Ø digital signage.



FPD Supply/Demand Balance (000 m2/Quarter)

Основные типы современных дисплейных устройств и их размеры

Table 1: Average Diagonal Size of Key FPD Applications

Key Applications	2010	2011	2012	2013	Average Size Difference (2010-2013)	
Desktop Monitor	19.9″	20.3″	20.7″	20.9″	1.0″	5%
LCD TV	33.2″	34.5″	35.9″	36.1″	2.9″	9%
Mobile PC	13.6″	12.8″	12.1″	12.2″	-1.4″	-10%
Mobile Phone	2.4″	2.6″	3″	3.3″	0.9″	38%
OLED TV	15″		55″	55″	40.0″	267%
Plasma TV	46.3″	47″	48.1″	50″	3.7″	8%
Portable Media Player	2.8″	3.1″	3.1″	3.6″	0.8″	29%
Portable Navigation Device	4.3″	4.5″	4.5″	4.6″	0.3″	7%
Public Display	41.7″	41.3″	44.9″	46.5″	4.8″	12%

- Мобильные персональные компьютеры
- Mobile PCs are the only key segment where average screen size is falling as smaller-sized tablet PCs take share and the ultra-portable segment grows within notebook PCs.
- OLED TV
- Both LG and Samsung invest in new manufacturing capacity.

v Другие параметры дисплеев, улучшенные к настоящему времени

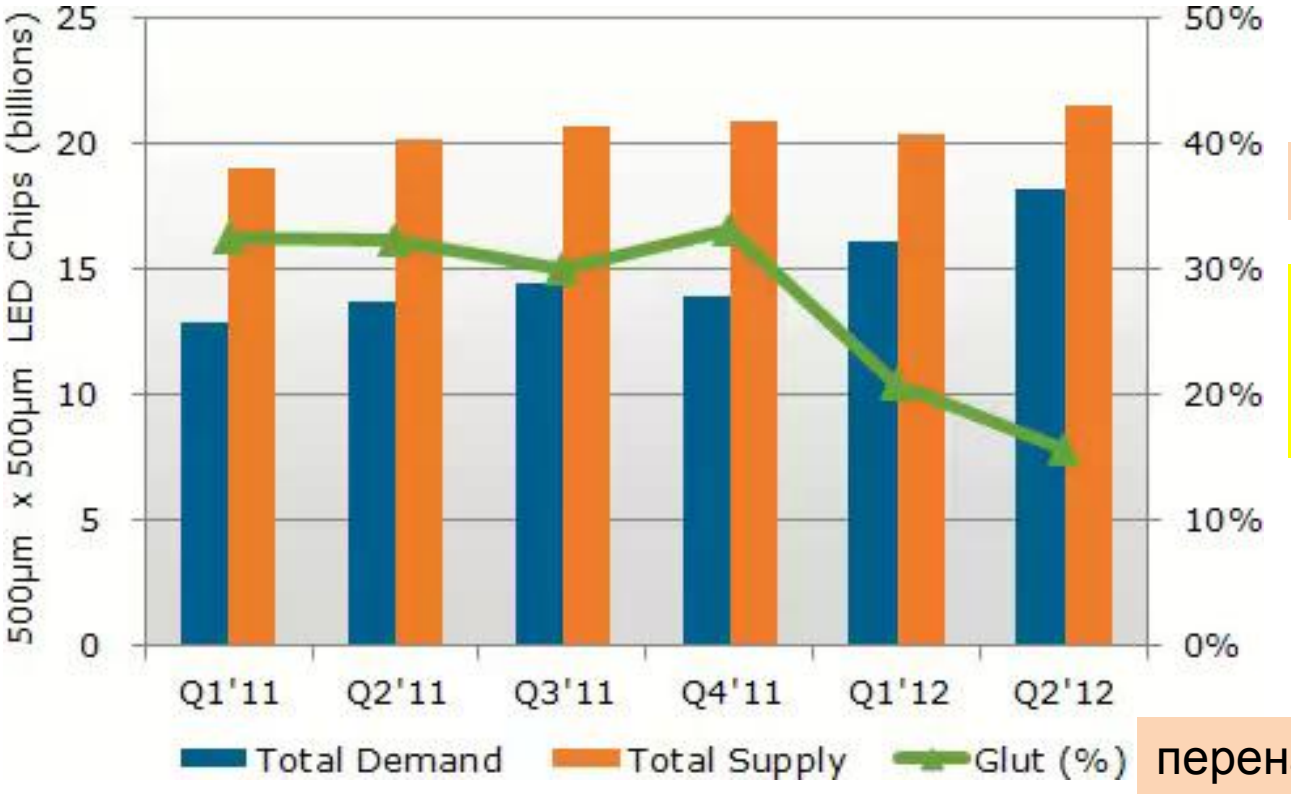
Ø higher resolution,

Ø wider viewing angles,

Ø integrated touch functionality,

Ø slimmer and lighter form factors

Спрос на светодиоды для подсветки ЖКД и освещения в 2012



Поставки / Спрос

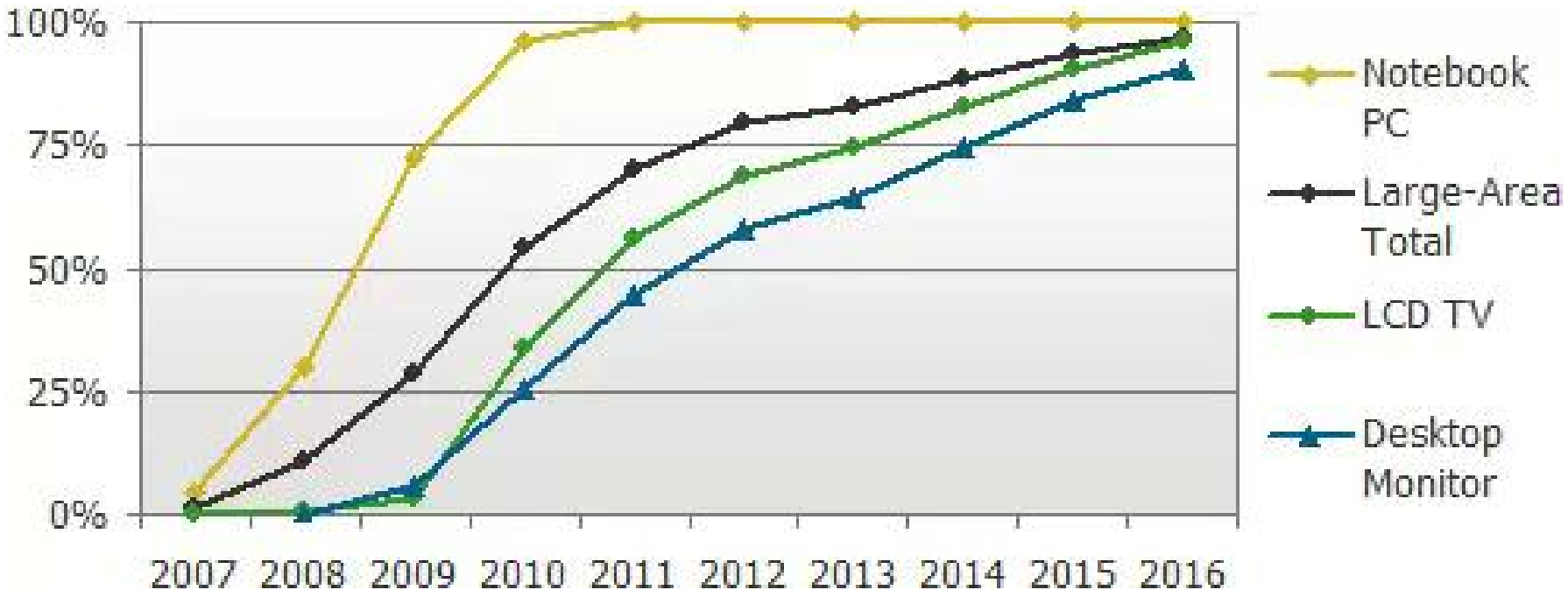
LED Supply/Demand for Backlight and Lighting Applications

перенасыщение

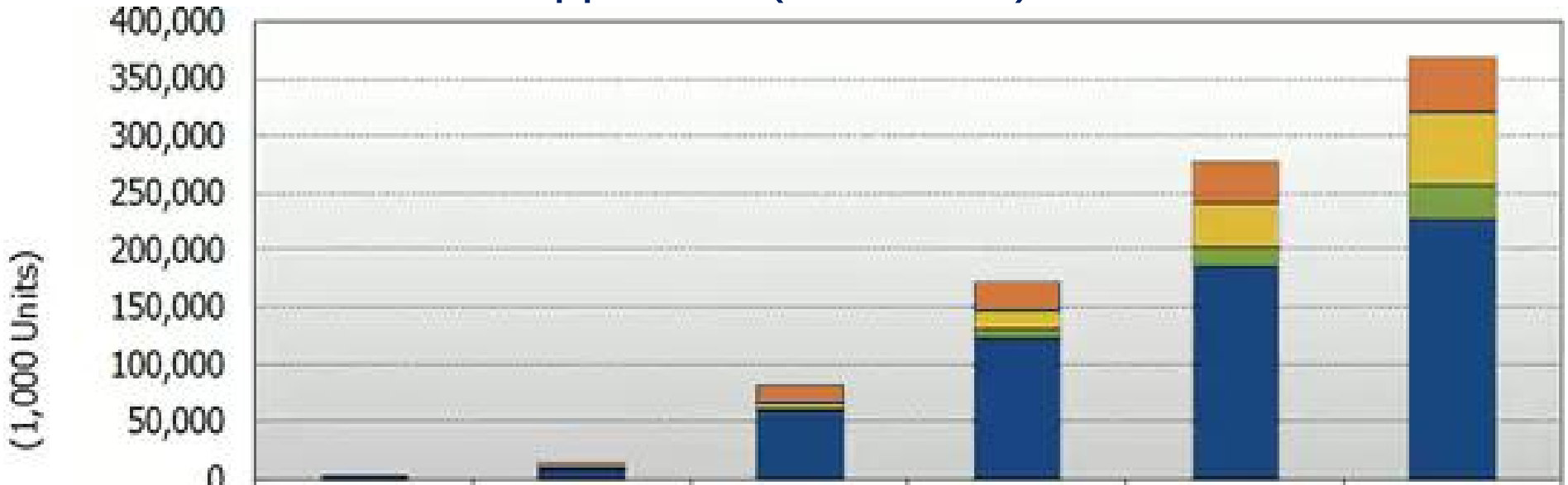
Key players: Samsung LED, LGIT and Lextar

- Светодиоды – доходы с конца 2010 г. – уменьшение цены светодиодов и маржи
- Почти не было инвестиций в приложения светодиодов – уменьшение перенасыщения
- Проникновение светодиодов в рынок освещения должен достигнуть 16.8% в 2015.
- LED street lights will gain higher penetration in lighting due to government incentive programs, such as the 12th Five-Year Plan in China and the LED subsidy policy in Taiwan, as well as continued growth in commercial applications.
- LED bulbs and fluorescent tubes are growing in Japan due to government incentive programs and energy-saving consciousness, especially following the March 2011 earthquake.
- sales will continue to rapidly increase in Japan since 2012. Other regions, such as China, the US and Korea, have aggressively promoted LED lighting.

Проникновение светодиодных подсветок в рынок 10”+ TFT LCDs

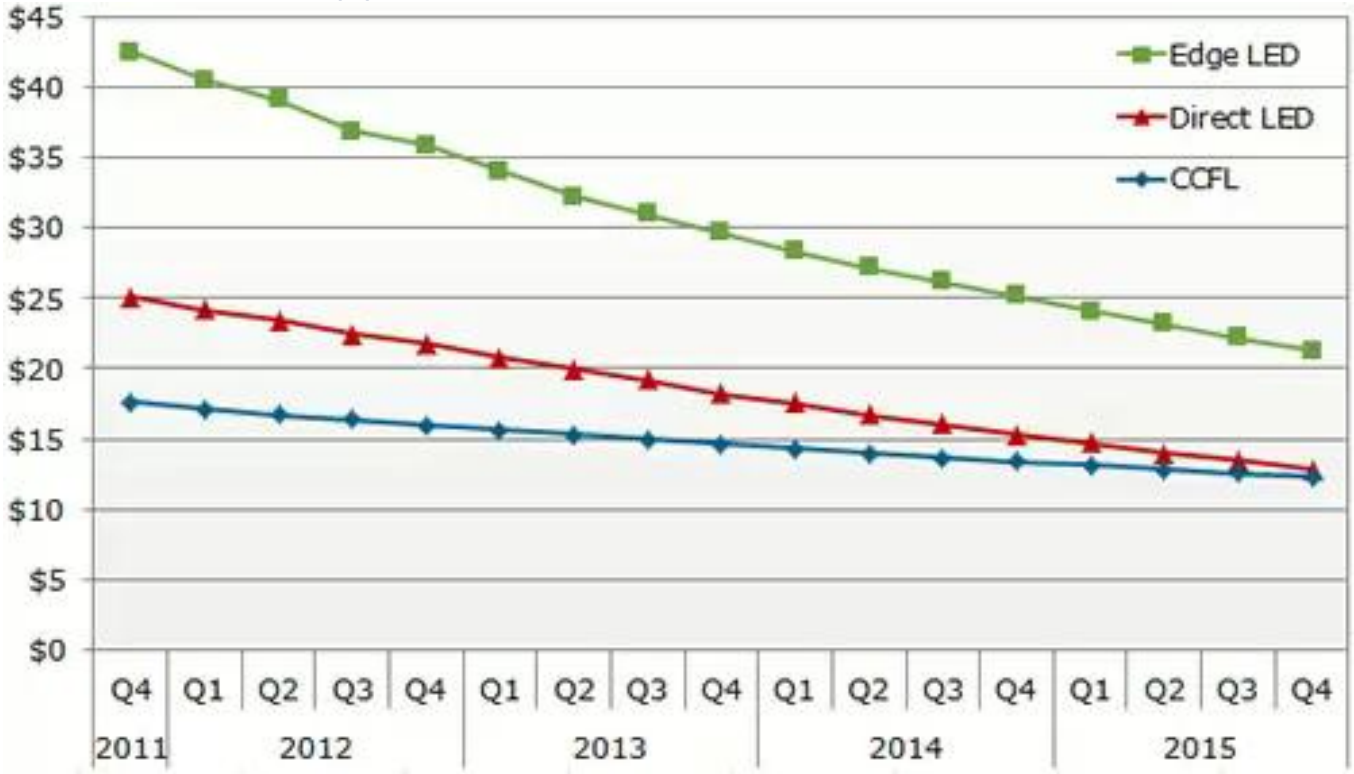


Large Size (10”+) LED Backlight Shipments by Application(Thousands)



	2007	2008	2009	2010	2011	2012
Others	32	5,681	16,202	27,270	36,419	48,248
LCD TV	23	196	3,674	15,137	39,224	64,073
Desktop Monitor	0	8	1,322	7,716	15,674	30,860
Notebook PC	2,189	8,219	59,635	122,814	185,816	225,063
Large Total	2,244	14,104	80,834	172,937	277,133	368,245

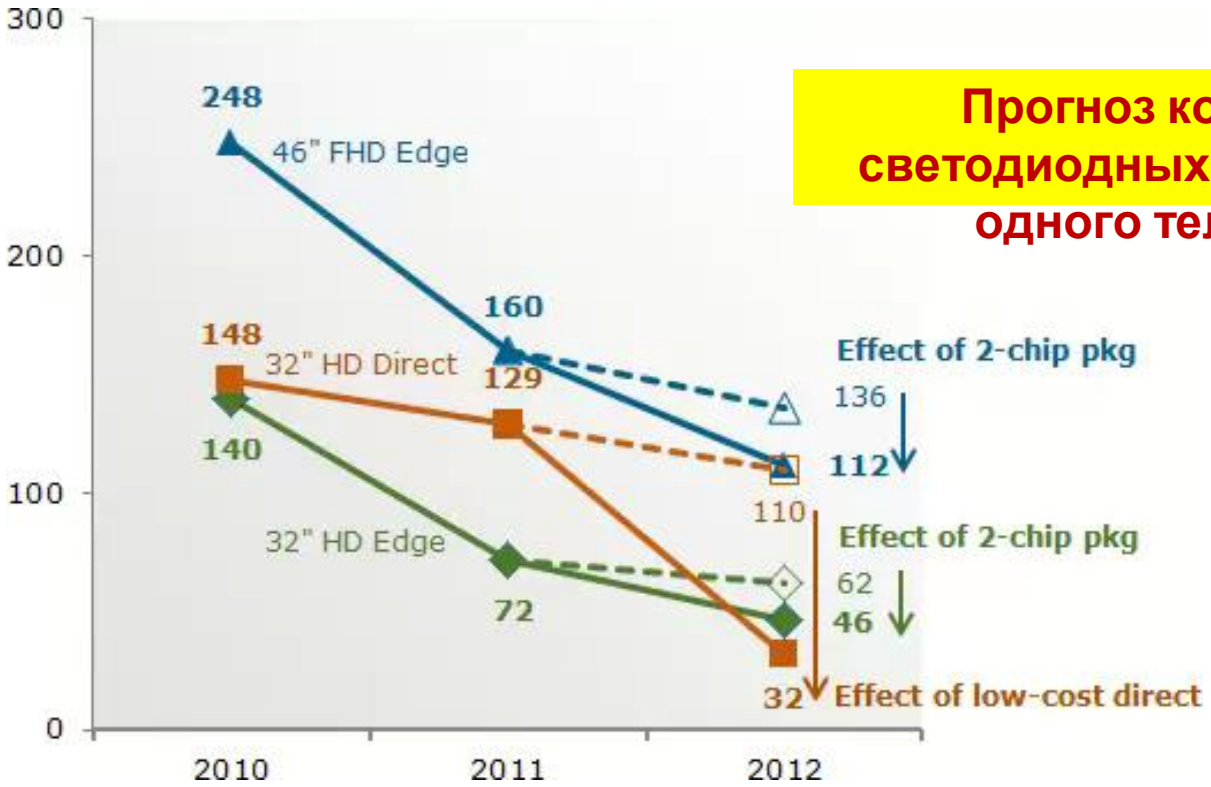
Удешевление фронтальной светодиодной подсветки



Backlight Cost Forecasts for 32” HD 60 Hz LCD TV Panel

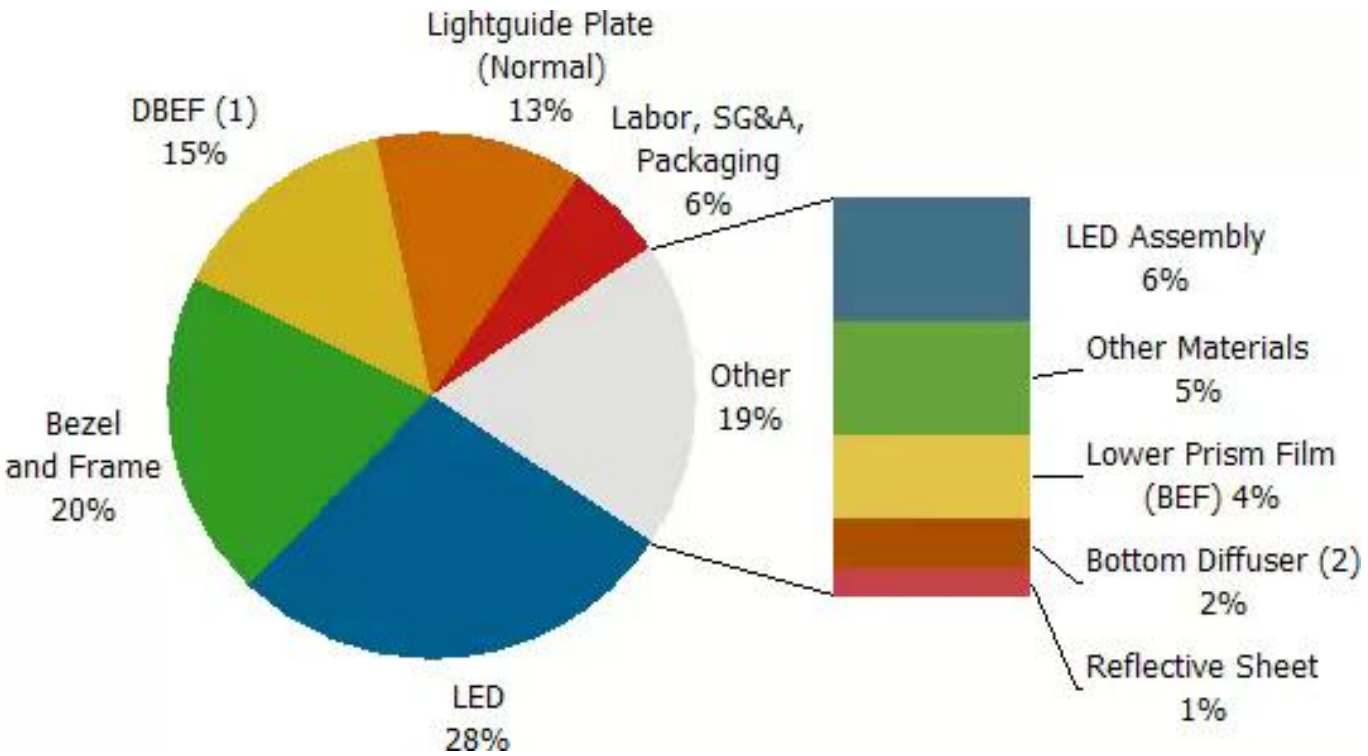
- TV makers are changing their strategies on direct LED-backlit TV.
- Instead of high picture quality, set makers have chosen low-power consumption with a corresponding lower price as selling points for this new type of LED-backlit TV.
- This will increase its competitiveness with CCFL-backlit LCD TV and even CRT TV.

Прогноз количества светодиодных корпусов для одного телевизора



- The cost savings come from using roughly half as many LEDs, as well as the replacement of light guide plates, optical film, and other materials with lower cost diffuser plates and lens structures on the LEDs. The reduction in LEDs and other materials lowers power consumption, but requires a thicker profile. Brightness is lowered to 300 nits as opposed to 450 nits for edge-lit LED or CCFL, and lack of dimming reduces the contrast ratio and image quality.
- TV makers have been adopting 2-chip LED packages to reduce the number of packages and to reduce optical film use. The number of LED packages used per set with direct backlights is expected to be less than that of sets with edge backlights.

Структура светодиодной подсветки



- The core components in a TV with an LED backlight unit

Ø LED chips,

Ø LGP (light guide plate), - световодная пластина

Ø DBEF (dual brightness enhancement film) – пленочный усилитель яркости

Светодиодные подсветки тянут за собой рынок полимеров

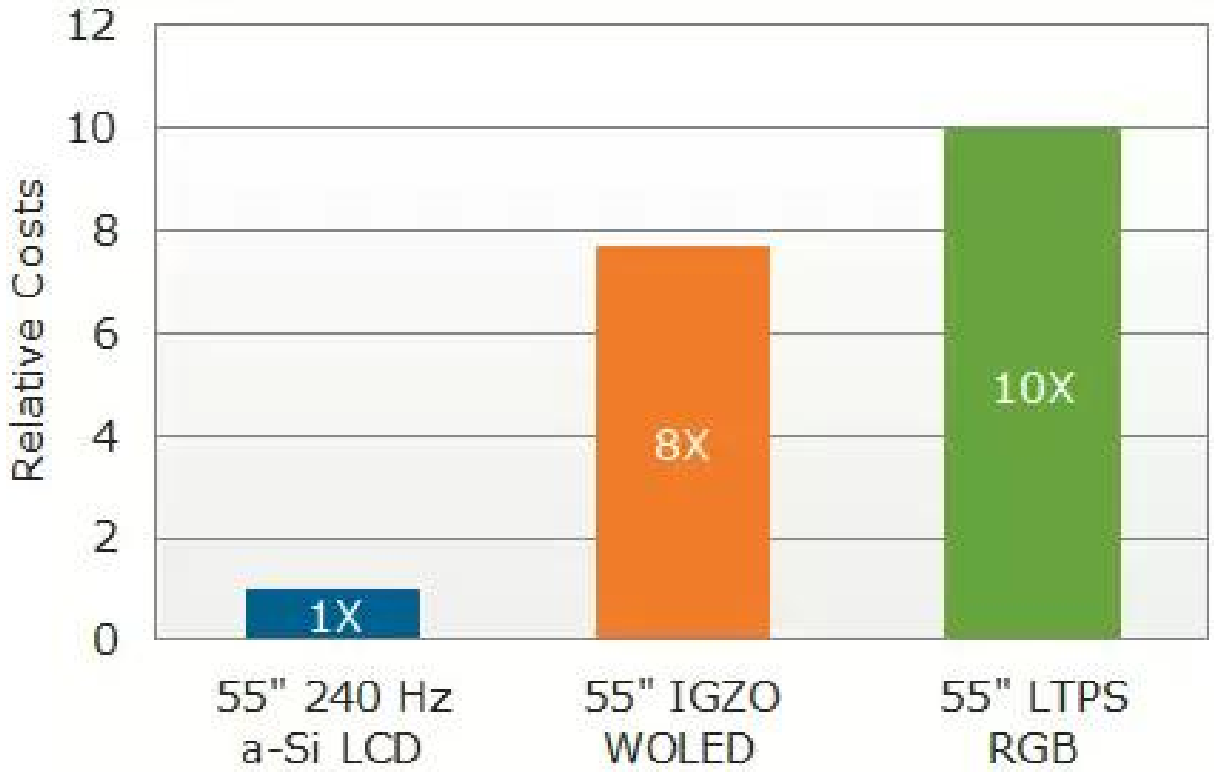
- LED will be the mainstream light source in all LCD applications due to slim design, low power consumption and the fact that it enables high display performance. This represents an opportunity for display materials suppliers:
- For example, optical polymethyl methacrylate (PMMA) used in light guide plates, white polyester (PET) for reflector film, and sapphire for LED wafer substrates.
- PMMA shortages have limited production of TV light guide plates.
- PMMA and PET suppliers are slowly expanding capacity since they need time to add new plants and face financial limitations

Global PET Supply/Demand Forecast

The backlight unit (BLU) represents one of the highest costs within the TFT LCD components and materials market.

Рынок и применения органических светодиодов (OLED)

- Active-matrix organic light-emitting diode (AMOLED) – a rapidly growing and highly promising technology for all display applications. Based on planned investments, the market will grow nearly tenfold from 2.3M square meters in 2012 to more than 22M in 2016.



Relative Manufacturing Costs of Technologies for 55” TV Panels

higher costs are mainly a result of low yields and high materials costs

Table 1: Comparison of LTPS, a-Si, and Oxide TFT for AMOLED

Characteristic	LTPS	a-Si	Oxide TFT
Electron mobility	Excellent 10-500 cm^2/VS	Poor 0.5 cm^2/VS	Good 1-40 cm^2/VS
Uniformity	Poor	Excellent	Good with amorphous type, poor with crystalline type
Stability	Excellent	Poor	Poor
Scalable	Limited to <40"	Excellent, >100"	Potential to 100"
Process temp	High >400°C	Typical ~300°C, some low temp process can be ~150°C	Typical ~200°C, but some anneal at 350°C
Cost	High	Low	Medium
Availability	Yes MP	Demo for AMOLED; Announced by RiTdisplay and IGNIS; MP by end of 2011	Demo for AMOLED; MP estimated by end of 2012
Challenges	Uniformity, cost, scalability	Poor mobility; poor stability	Threshold voltage unstable; manufacturing process not mature

Преимущества OLED

- OLED displays can provide
  - Ø high contrast ratio,
  - Ø fast response time,
  - Ø wide color gamut,
  - Ø wide viewing angle,
  - Ø in a broad temperature range,
  - Ø low power consumption.
- In addition, OLED technology enables thin devices that can be both flexible and transparent.
- OLED displays operate through direct emission, as opposed to transmissive LCD or reflective displays, which enables area lighting

- However, it still has many hurdles to overcome including:
  - Ø high manufacturing costs,
  - Ø ability to mass produce,
  - Ø maintaining energy efficiency and uniformity as the size increases.

OLED производители

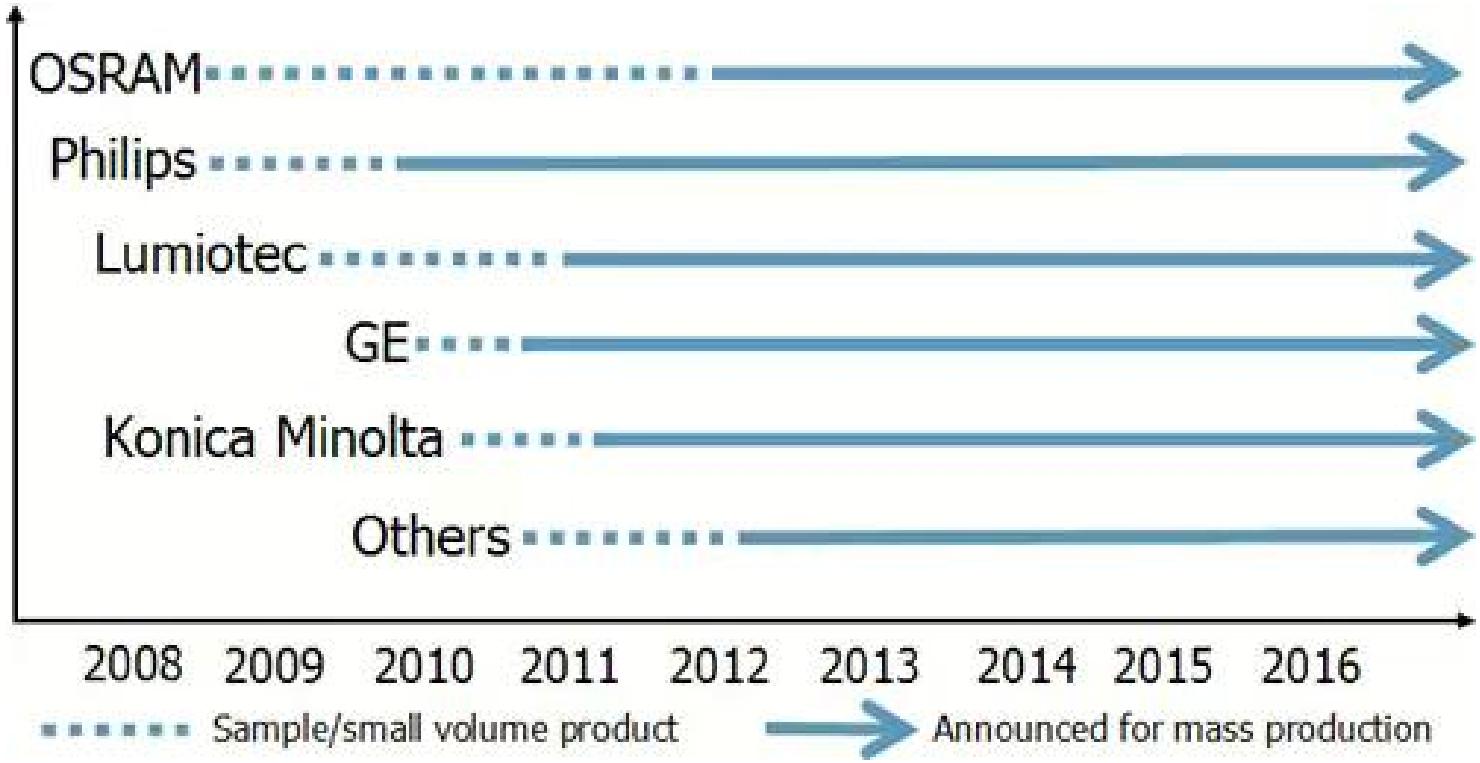
- OLED emerged in the 1980s from laboratories at Eastman Kodak in the US and Cambridge University in the UK, and was first commercialized in the late 1990s.
- Enthusiasm has increased recently as Samsung Mobile Displays has started manufacturing active matrix OLED (AMOLED) displays in a Gen 5.5 fab and announced plans to build a Gen 8 fab (as did LG Display), and several other suppliers entered or re-entered OLED display manufacturing, including AUO, CMI, IRICO, Tianma, and BOE.

OLED display revenues

- 2011 >$4 billion (4% of flat panel display revenues)
- forecast
- 2018 >$20 billion (16% of the total display industry)
- OLED lighting gained momentum in 2011
- forecast 2018 $6 billion.

- OLED is now a mass-market technology in small/medium displays, particularly in smart phone applications.
- Investments in Gen 8 (2200 × 2500 mm) fabs indicate that AMOLED will compete in larger size applications, such as in TV and mobile PCs
- Samsung released a 7.7” AMOLED tablet PC in December 2011, and more tablet and other mobile PCs are expected in 2012.
- LG enters the market in 2012 with a 55” AMOLED TV.

- OLED technology has progressed in areas including
  - Ø organic materials,
  - Ø color patterning,
  - Ø electronic driving methods,
  - Ø encapsulation.
- However, the ability to scale OLED display manufacturing to fabs larger than the current Gen 5.5 has yet to be demonstrated



OLED Lighting Manufacturing Participant Roadmap

Manufacturing Capacity Devoted to High Resolution Backplane Production

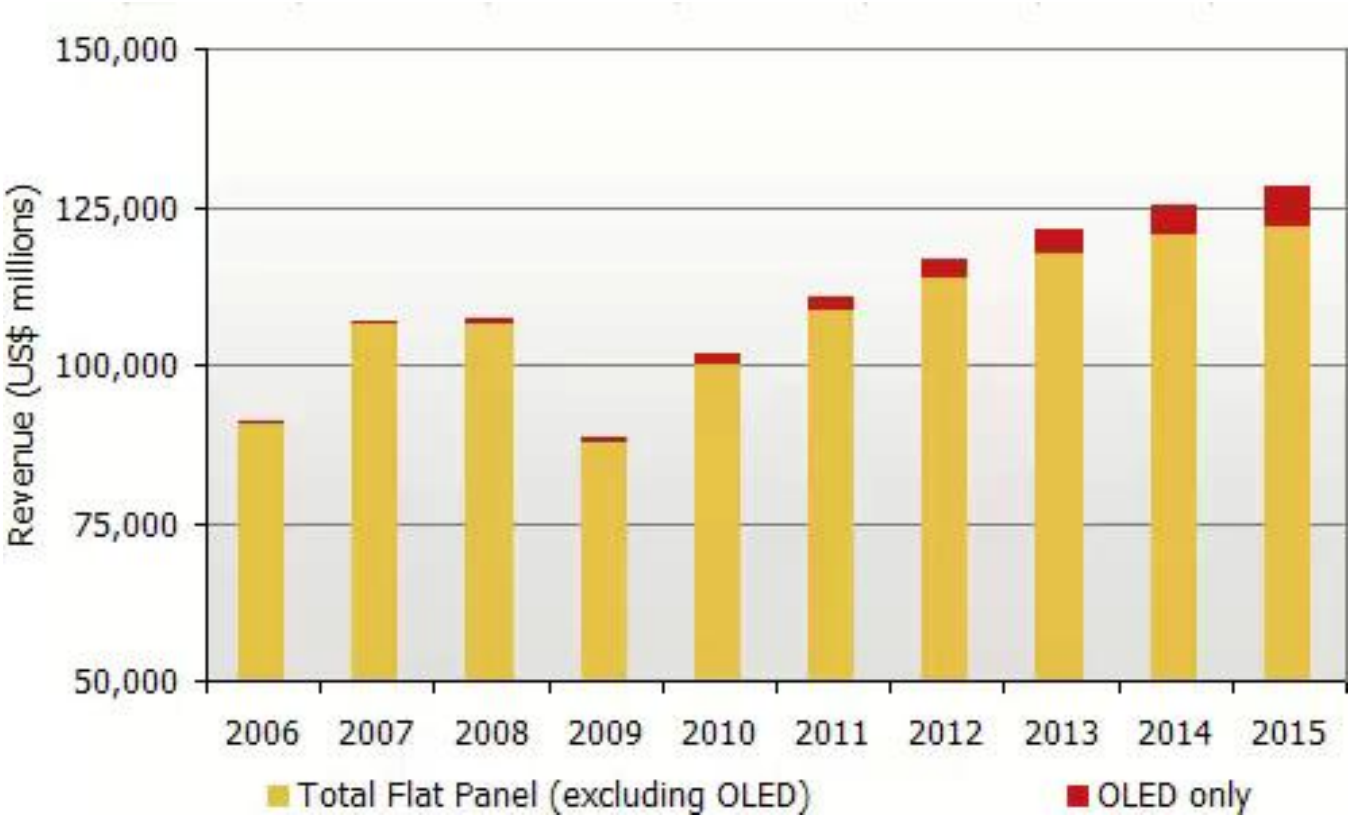
- LTPS (low temperature polysilicon)
- IGZO (indium gallium zinc oxide)
- TFT technologies critical to production of the high resolution displays.
- These TFT technologies employ high mobility semiconductor materials, which allow panel manufacturers to shrink TFT dimensions and increase light transmission.
- LCDs with greater than 230 ppi (pixels per inch) resolution, such as Apple's Retina Display, are enabled by high transmission because it minimizes power consumption, allowing mobile devices to run longer without recharging.

Технологии OLED

- IGZO: indium gallium zinc oxide.
- WOLED: white OLED with color filters.
- LTPS: low temperature polysilicon.
- RGB: red, green, blue (direct emission) OLED.

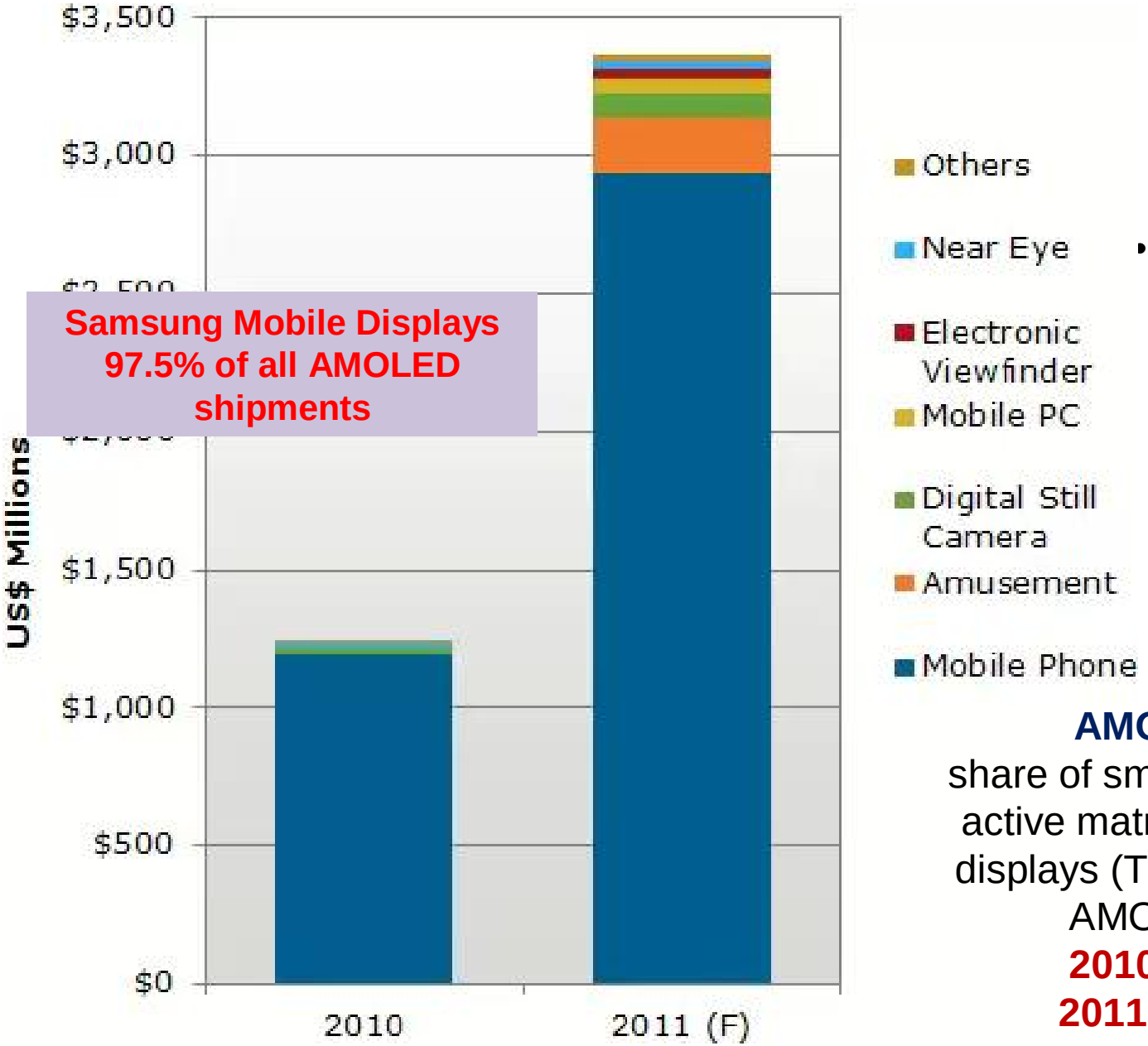
- While indium gallium zinc oxide (IGZO) and other forms of oxide TFT show great promise for backplanes, progress in scaling up LTPS production is also being made by increasing the excimer laser beam width to 1300 mm. In addition, the current method of depositing red, green, and blue materials by evaporation through a fine metal mask is being continuously improved. Pixel densities of 250 ppi are now possible, and over 280 ppi is feasible.

OLED Display Forecast 2006-2015



- Active Matrix Organic Light Emitting Diodes (AMOLEDs) – 110% revenue increase in 2008.
- OLED display revenues will exceed $6 billion in 2015, up from $591 million in 2008.

Annual Small/Medium AMOLED Revenue by Application



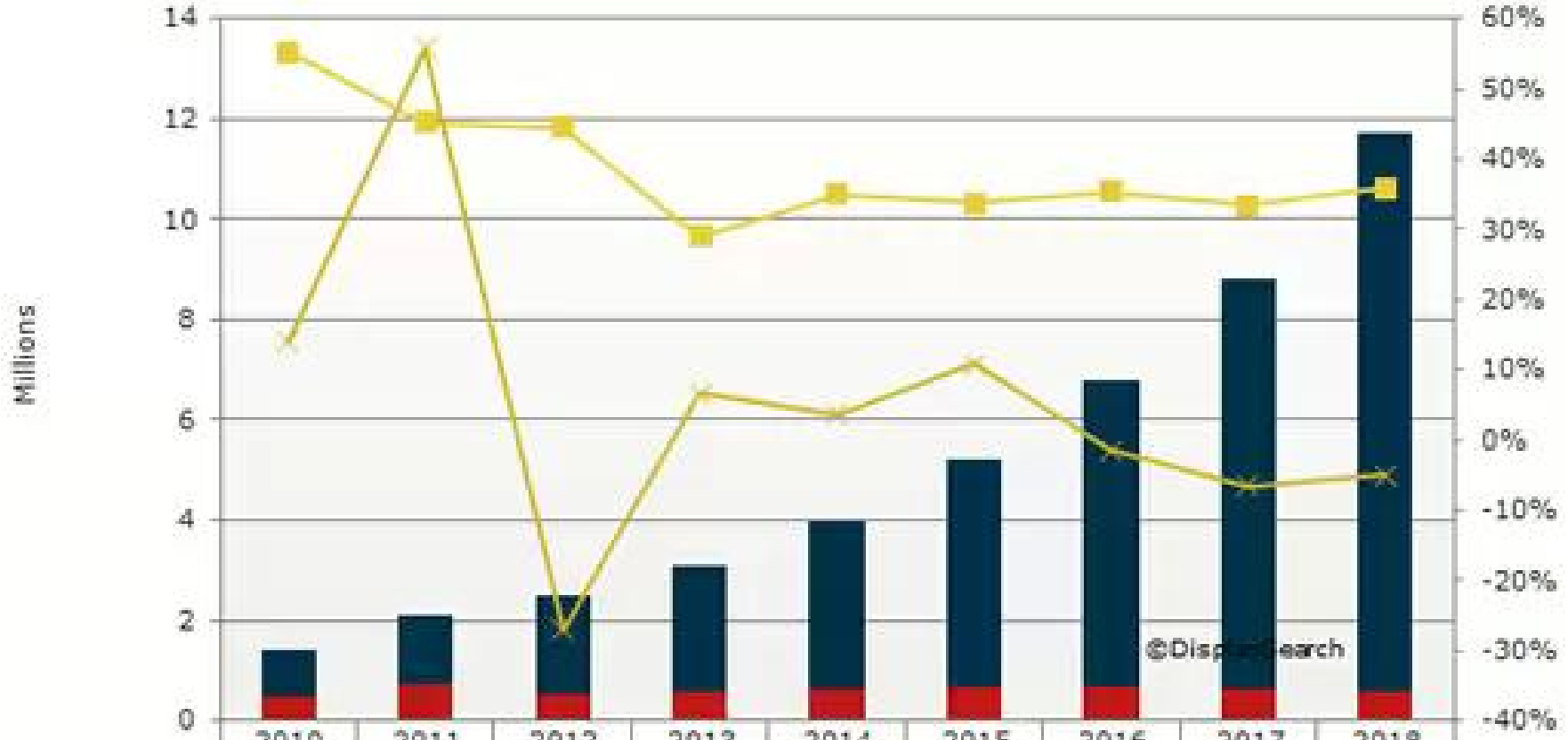
Samsung Mobile Displays 97.5% of all AMOLED shipments

- 2011
- AMOLED shipments
- 90 million units
- 97% Y/Y
- Revenue
- $3.36 billion,
- 169% Y/Y

AMOLED
share of small / medium active matrix flat panel displays (TFT LCD and AMOLED)
2010 - 6%
2011 - 12%

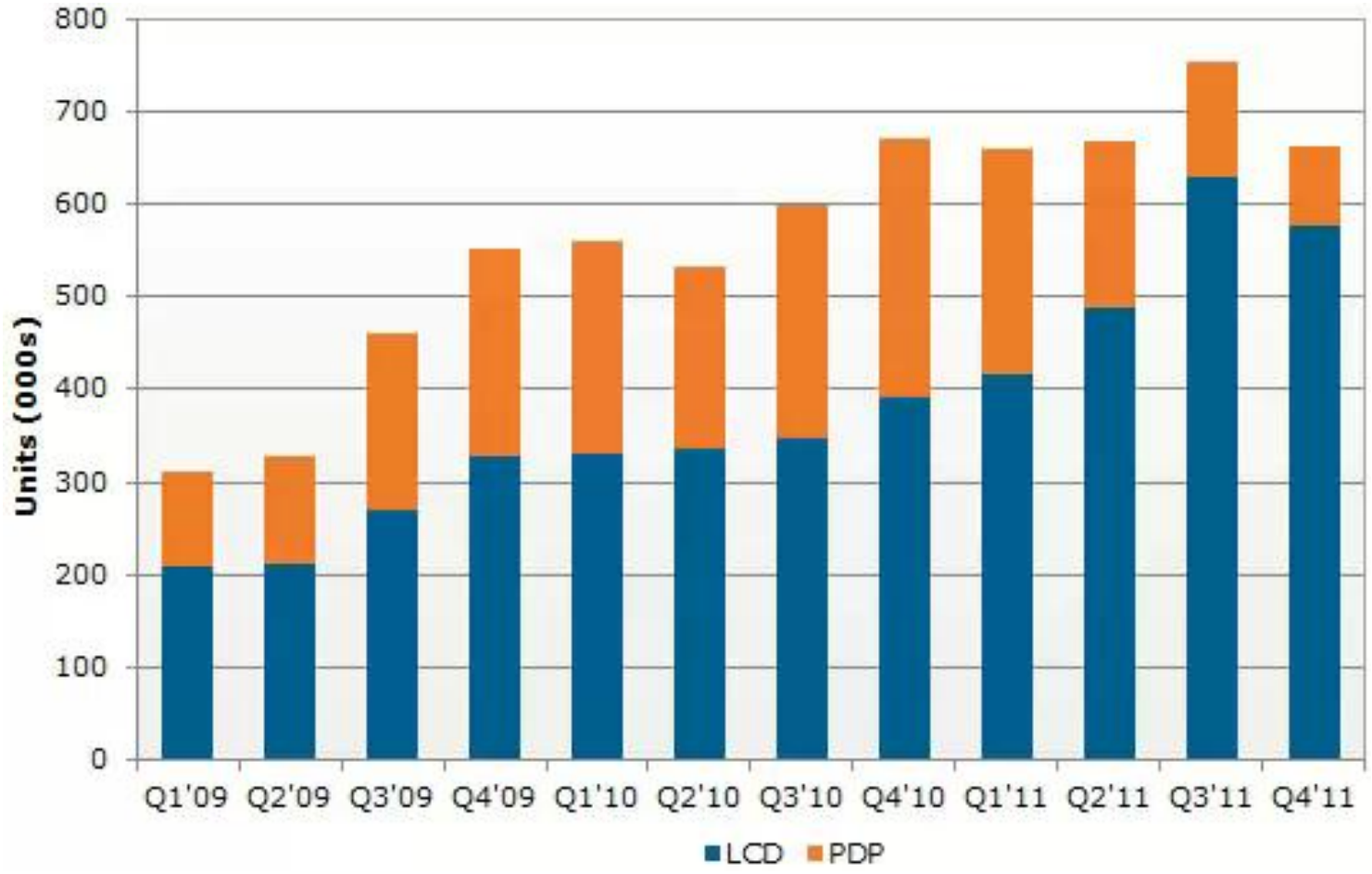
Сегменты рынка ППД со светодиодными подсветками

Worldwide LCD Commercial Public Display Shipments and Forecast

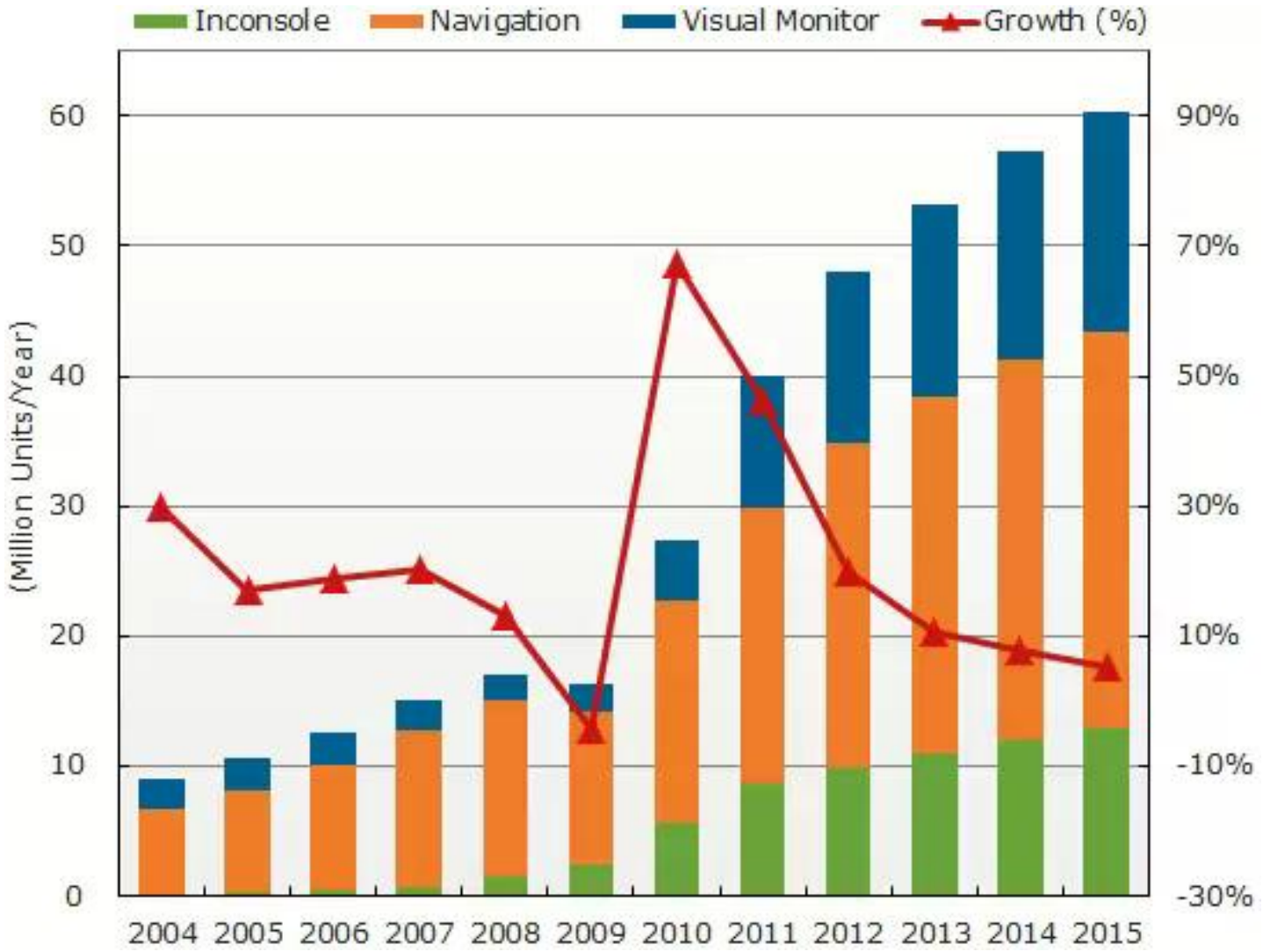


	2010	2011	2012	2013	2014	2015	2016	2017	2018
LCD 40"+	926.9	1,346.2	1,945.7	2,508.7	3,387.1	4,532.3	6,135.5	8,181.2	11,112.1
LCD 26-39"	479.2	746.7	544.8	580.8	602.4	668.3	659.1	615.8	584.8
Y/Y Growth 40"+	55%	45%	45%	29%	35%	34%	35%	33%	36%
Y/Y Growth 26-39"	14%	56%	-27%	7%	4%	11%	-1%	-7%	-5%

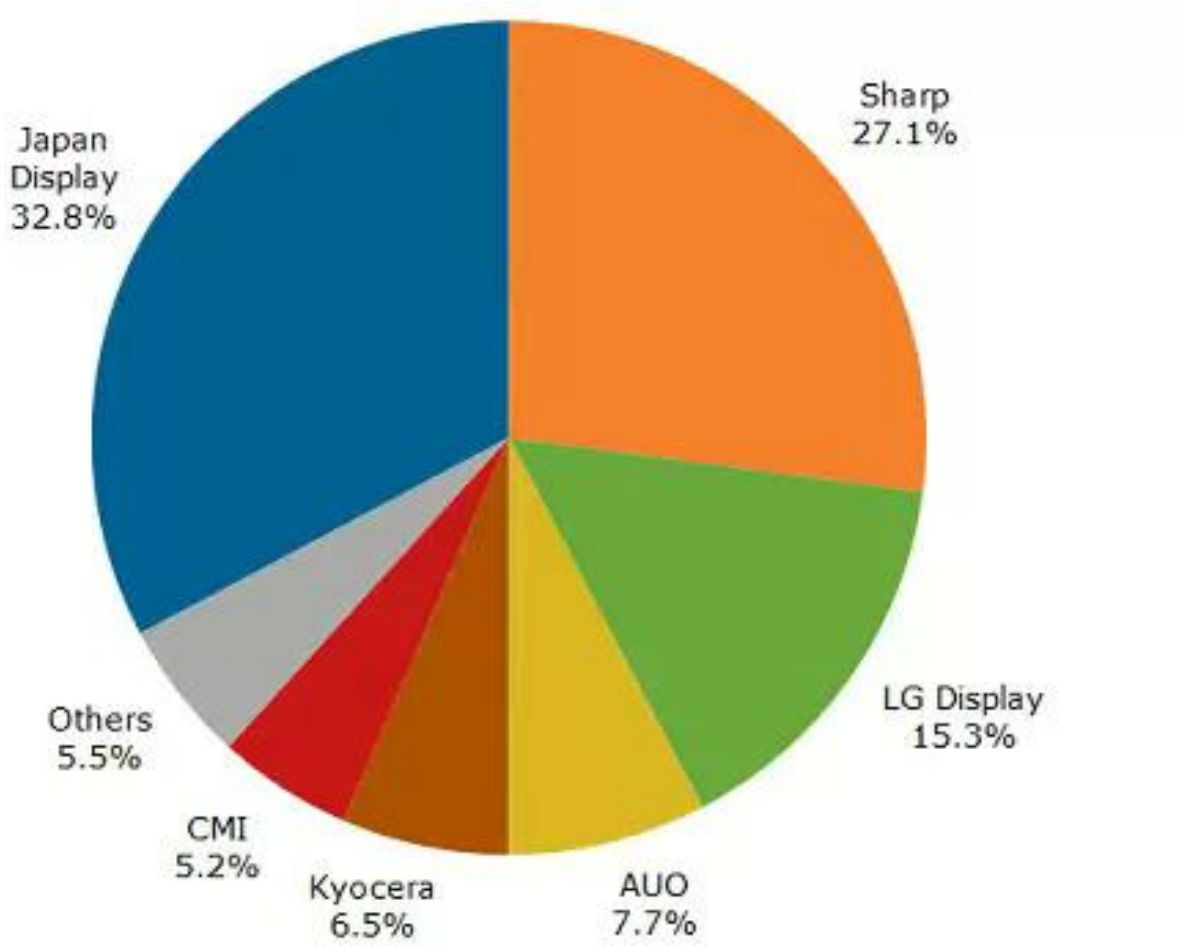
Worldwide FPD Commercial Public Display Shipments by Technology



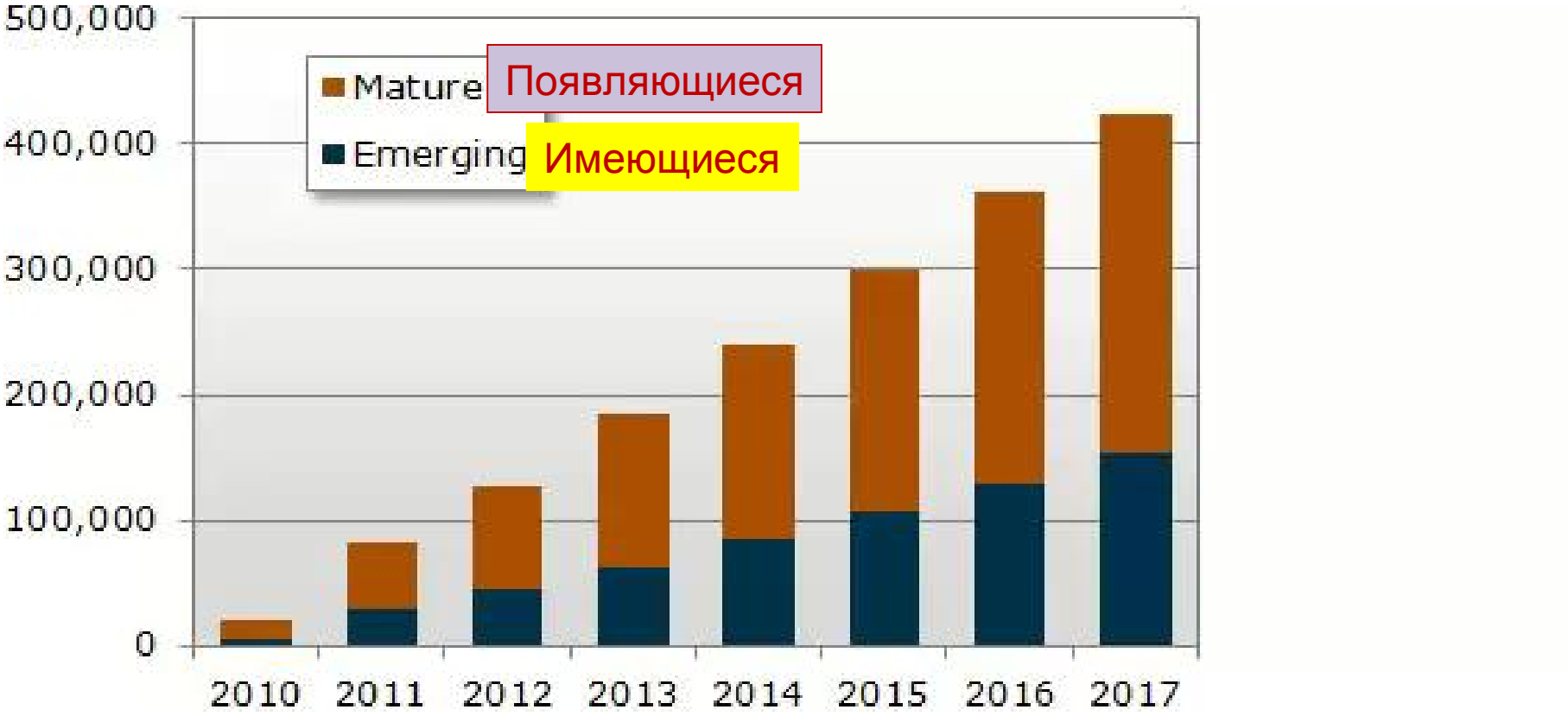
Automotive Display Demand by Application (Shipments)



Shipment Share for Automotive TFT-LCD Makers (2012)

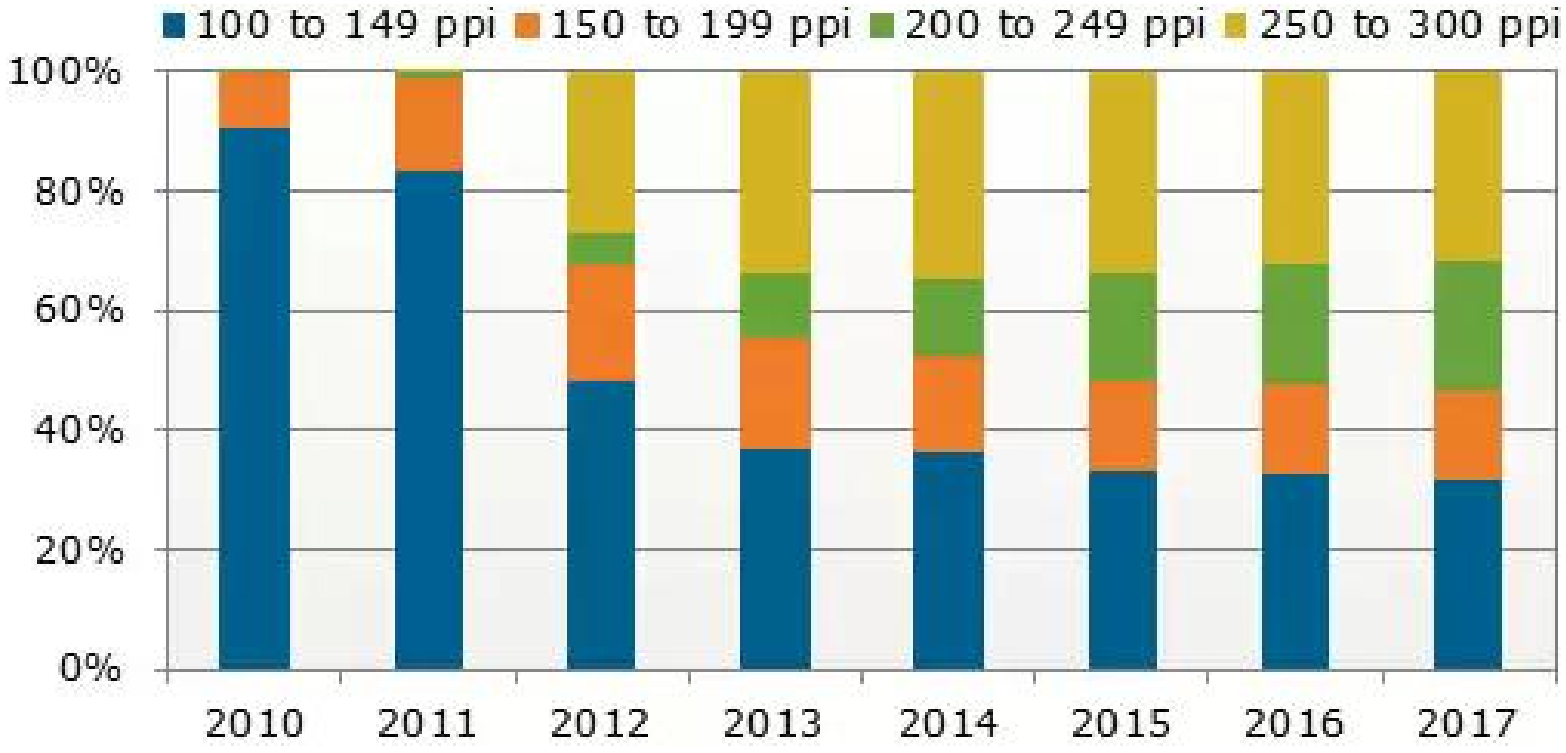


Worldwide Tablet PC Emerging and Mature Market Shipment Forecast



Worldwide Annual Tablet PC Pixel-Per-Inch Forecast

- ppi – pixel per inch = 1/25 пиксела / мм



Спасибо за внимание