Market scenarios for the display industry 2018

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In 2012, we looked at a number of scenarios for development of the display industry:

	Base case	Tech race	Race to the bottom	a-Si wins since "Good enough"	Display industry saves itself
Metal oxide	Slow roll out for hi-def TV & mobile devices. Retrofit of a-Si	Metal oxide becomes important but coexists with architecture led LTPS	Metal oxide destroys LTPS value proposition but gains no premium over a-Si	Metal oxide fails to be important in comparison to a-Si	Metal oxide and a-Si coexist, with MO positioned above a-Si
AMOLED	2-3 players develop positions mostly in mobile devices	AMOLED flourishes and hits high-end price points in EU, Japan and US	AMOLED survives in mobile apps as MO TFT becomes cost competitive with a-Si	AMOLED flounders and remains a niche technology	AMOLED has a role for mobile devices and some TV and enables flexible
Market development	Mobile devices still more important. TV replacement faster, but not by much	Market is excited by new offerings. Some TV growth delivered in return	Markets grow but at low price points. Prices fall at 20%+	Markets grow but prices continue down	Price declines slow down as newer technology gains ground
Impact on players	Smaller players in Taiwan and Japan close or convert. New BRIC players	AMOLED or LTPS capable players break from the pack	Faster exits from the industry. Customers gain more power in funding future fabs	Niche technologies fail. Legacy transfer continues faster and more new players	Players begin to specialise in technologies or regional markets
Impact on profits	Profits stabilise but at lower levels. Participation in novel tech or materials key	Increasing profits for technology leaders and for AMOLED "all-in" players	Profits remain poor. Apple, Samsung and HP pay for the fabs they want	Profits remain poor, which leads to more vertical models. Merchants are poorer	Profit improves as display value offsets material cost
	30%	10%	30%	25%	5%

Trends identified in this thinking:

- Expansion of role of LTPS and oxide in the total picture
- Role of big brother sponsors of innovation in the industry (such as Apple)
- Internationalisation and consolidation
- Scale of growth of AMOLED
- Overall industry profitability and price progression

Source: HCL

Five years on, how well did we predict the issues and how did the industry develop?

Issue	What we thought would happen	What actually happened
Dominance of a-Si	We believed that a-Si would continue to be the dominant display technology	a-Si still represents over 80% of industry capacity
Role of big brothers pay	We predicted that key innovations would come from companies like Apple	Apple X moves industry to Flex OLED on major scale
Internationalisation	We thought we might see some selective investments in protected markets	Ongoing discussion on fabs in India and USA but not in Brazil
Price progression and industry profits	We worried that prices would continue to fall at fast rates	Prices fell in small panel markets but withdrawal of Gen 7 capacity improved prices in large panel
Growth in OLED	Modest growth in OLED	Modest growth in large panel OLED but huge capacity step up in flex OLED
Novel technology gets compensated	Innovations in technology commoditise within 3 years	OLED has managed to maintain an ongoing price advantage

- Our outlook was more bleak than the actual industry progression: OLED was a more valued and larger scale technology than we imagined and capacity was taken out of the market

Source: HCL

So it is now time to update our scenario based market view. What are the uncertainties?

QD and OLED penetrations in large panel

- Actual progressions in large panel OLED and QLED

Role out of flexible display businesses

- How the number of players investing into flex OLED get on for small panels

Scale and chaos caused by Gen 10

- The scale of Gen 10s built in the next five year and the impact of this on the rest of the industry

Emergence of new technology

- MicroLED, OTFT, new semiconductors or TFT patterns, new touch technologies and enhancements to viewing performance

Consolidation of leader board

- Whether we see the Koreans and top 2 Chinese players pulling away from the pack or a more balanced view

Role of "Big brothers" and new players

- This remains a theme from earlier but will Apple, Huawei and Google and others actually get into the display business

Role for Gen 7 and 8 capacity

- The impact of what happens on Gen 7 and 8 capacity (and all the smaller fabs) is important once Gen 10 on the scene

Pricing and commercial environment

- As a result of the capacity changes on the display industry

Source: HCL

Let's think about the extremes: What could they be? And perhaps a case more in the middle

Worst case: Market Chaos	Base case: Market competition	Best case: Tech future
Many Gen 10s arrive (700k/mo or more of Gen 10 capa)	2-3 Gen 10s arrive; others withdrawn	Only 1-2 of the Gen 10s emerge. Gen 6 flex effective shortage
Gen 7s find no applicable markets but are not rapidly closed	Some 7s closed and others partially rededicated	Gen 7 fabs find new markets to pursue
Prices fall very fast in all large panel categories	Pricing mostly falls with some rises in segments at times	Solid VC backed set of invesments support new innovations
Massive oversupply in small flex OLED also causes chaos	Oversupply in OLED corrects with time	OLED and QLED are valued by consumers as are other new technologies
New technology is commoditised	Field of players continues to increase	Top tier players pull away from pack and smaller players differentiate

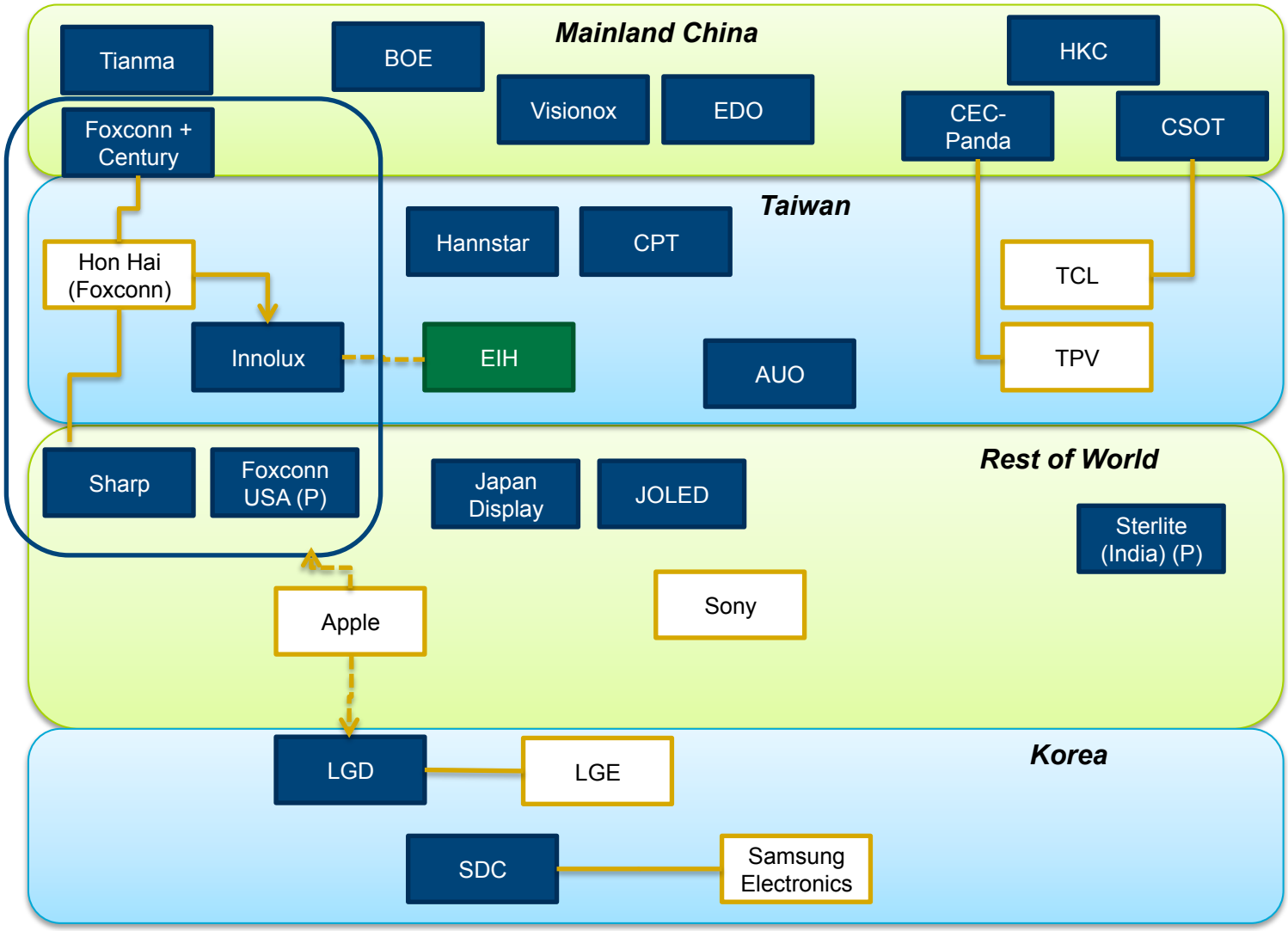
Source: HCL

These then are the total list of scenarios

	Base Case: Competitive markets	Worst case Capacity chaos	Best case Tech future	OLED and a-Si plus big brothers	Consolidation case
Capacity outlook	2-3 Gen 10 fabs and some Gen 7 capacity survives	Large amounts of Gen 10 capacity (> 700k/mo) and Gen 6 massive oversupply	Only 1-2 Gen 10s and Gen 7s find new markets. Tight Gen 6 supply	Ongoing OLED growth and a-Si remains important	New capacity arrives but industry consolidates
Technology outlook	Technology can hold premium positions at times	Technology appears but it commoditised rapidly	QD, OLED and other new technologies thrive	Only OLED and a-Si thrive: QD fails and others fail	Each of the leading clusters supports 1-2 technologies
Players and leaders	Some leaders, some followers: same as today	All players try to remain in head on competition	Leading set emerges and niche options for others	LG, Samsung, BOE CSOT lead OLED and others focus on a-Si	4-5 major groupings emerge overall
New market options	New markets emerge to support capacity outlook	No significant new markets to soak up demand	Autonomous vehicle display and other markets emerge	OLED markets thrive with a-Si for the rest	Samsung, LGD and Foxconn build new markets
Commercial outlook	Ongoing price erosion but not crushing impact	Rapidly falling pricing in all markets	Prices more stable and everyone enjoys	Weak but not horrible pricing. Big brothers support specific R&D	The top 5 grouping do well, others suffer. Higher pricing
Summary	More of the same: competitive markets and players	Dire commercial picture for all players Consumers win	Best case outcome with money paid for novel technology	A weak option where only two technologies thrive	The top groupings win (top 5 groups) with more stable pricing

Source: HCL

Remember we are talking about a chess board with the following pieces:



- Additional players have been appearing in the last years in both China and further abroad: HKC, EDO, Visionox, CEC-Panda

  Further abroad we have the planned India Fab of Sterlite/Twinstar and the Wisconsin fab of Foxconn. Other locations have also been rumoured

- Chinese companies rising up the rankings so that BOE will soon be the largest in terms of total capacity. What is noticeable now in this picture as compared to prior years is the number of Chinese players active also

Display Co
(P)= planned

Corporate

Source: HCL

What is clearly different to our last scenario piece is the now crowded field of Chinese players:

Clear leaders

BOE

- Amassing a major amount of capacity across many provinces
- Pursuing all technologies for all markets
- Will soon be display capacity leader but what sort of leadership will they espouse?

CSOT

- One of the display businesses that impresses us the most: a focused technology driven, narrow product range leader
- Putting bets into RGB OLED and also QD

Mid tier players

CEC

- Different fabs and investments all at Gen 8 across 3 provinces including work with Irico on display glass
- Technology agreements with Sharp and Innolux

HKC (Potentially)

- HKC is one of the top tier monitor makers in China and has rearward integrated into LCD making
- Have one Gen 8.6 fab already and thinking about two other fabs including a Gen 10.5 across three provinces

Small panel specialists (OLED)

Tianma

- Aggressively moving position in LTPS into trying to be a top tier OLED player
- Automotive strengths
- Gen 4-6 fabs

Truly

- Impressive previous player in smartphone/ phone displays and module making moving into LCD and OLED

Visionox

- OLED pure play with Gen 5.5 and new Gen 6 capacity
- Black Cattle Foods is major investor behind new Gen 6

EDO

- Another OLED pure play with Gen 4-6 capacity

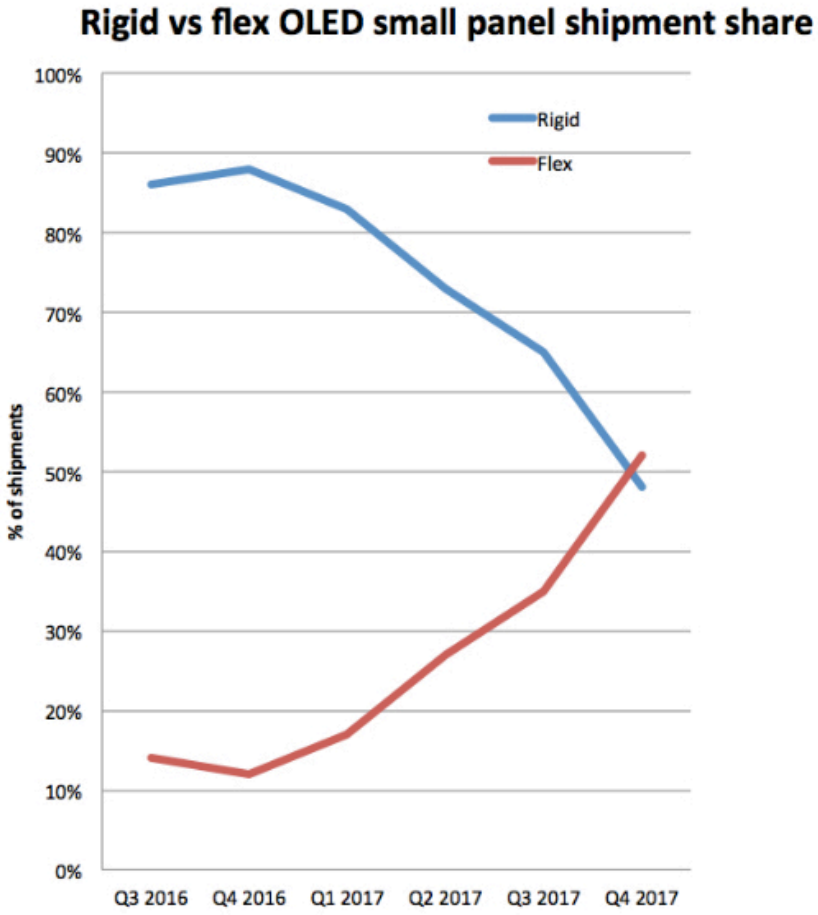
Source: HCL, IHS

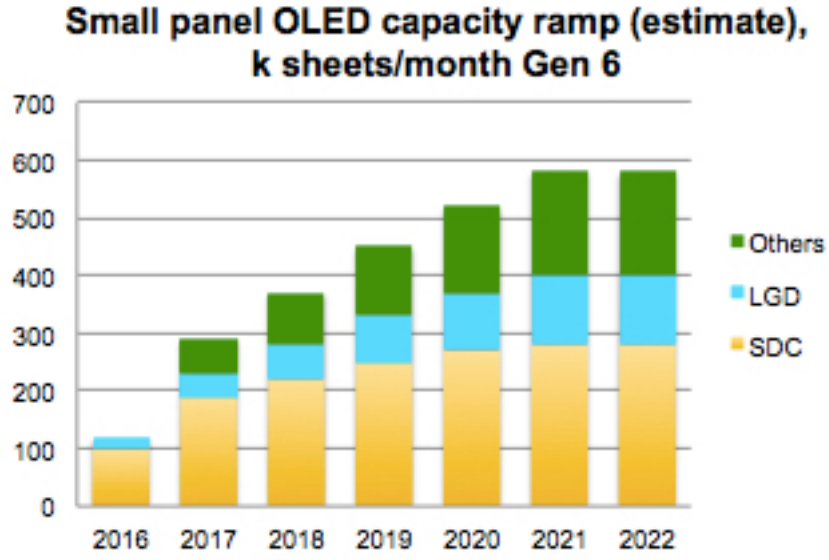
Issues at stake include the scope and impact of Gen 10 roll out: This is our general view but scenario thinking is also helpful

- Firstly, not all of this Gen 10 capacity will come line on line. The first Gen 10 players to market are more likely with the later capacity additions less likely
- However, enough new capacity will come on line to cause very real problems to owners of Gen 7 and 8 capacity
  - The weaker fabs and players will feel the pressure first (Mostly AUO and Innolux). Those players small Gen 7 fabs and weakest channel links may feel most pressure
- Based on what we have seen in previous cycles then this will create quite a bit of market chaos for the short *and* long term
  - Tumbling prices for many types of panel short term, and then capacity realignment long term
- We believe the winners here will be the Gen 10 builders with the strongest channels to premium large TV and education panel markets
  - Next will be the Gen 7/8 owners who have the strongest commercial load and those that move first with market strategies to keep load on these fabs or convert to new technologies. This is not a time for inaction. First movers win
- Overall though these moves will still be on the whole value destroying for the display industry and the net beneficiaries are consumers
- This will be a noisy and difficult period of realignment over 5+ years: first movers will win

Source: HCL

⋯and what comes of the flex Gen 6 capacity rush going into place now:





- There has been a mad pile into flex OLED Gen 6 capacity largely from the move of Apple. However, with the degree of success of the iPhone X not assured and the rush from many players to invest into flex OLED, it is unclear whether this will lead to massive oversupply in the medium term, or whether only some of the players will be able to ramp their capacity leading to a slightly better balance

Source: DSCC, HCL

…we wonder what will happen to issues such as innovation, technology development and the ability to pay for such as well as the role of the Chinese on the leaderboard:

Sources of innovation

- One of the fundamental concerns of a future industry that may be oversupplied and therefore subject to medium term margin pressures, is how will the industry continue to afford innovation:
  - Innovation like flex OLED
  - Innovation like rollable TV
- We wonder whether a new cast of characters will appear with MicroLED solutions
- Clearly the large powerful brands like Apple can use their economic might to direct supply chains, but there are fewer clear innovation leaders for other segments where Apple does not compete. Samsung/LGD have also shown a capability to self direct large scale innovation but not really any other player

Role of the Chinese on the leaderboard. Chinese government decision making

- For now we have a proliferation of players in China beyond the leading two (BOE and CSOT)
  - Large panel players such as CEC-Panda and HKC with quite expansive plans
  - Small panel OLED players Visionox and EDO with Tianma also making strong moves
- For now this seems to have been driven at the province level: we wonder if and when national level policy may drive consolidation to this picture and pick winners
- Once BOE is the true capacity leader in the display industry –what sort of leadership model will they choose?

Source: HCL

…and finally we wonder if all of this new capacity will spurn new applications and markets, and whether they will be big enough to make a difference:

- Our view has been that Gen 10s will first put pressure on sub-Gen 7 capacity (with perhaps Gen 6 somewhat immune immediately given its value for smartphone displays and mobile devices)
- The question is what will fill the ailing Gen 7 capacity – curved, colourful displays for autonomous vehicles? What else? What else has enough area to soak up enough of the capacity?

Source: HCL, Daimler picture

So let us define a Base Case scenario looking out 5 years:

	Base Case: Competitive markets
Capacity outlook	2-3 Gen 10 fabs and some Gen 7 capacity survives
Technology outlook	Technology can hold premium positions at times
Players and leaders	Some leaders, some followers: same as today
New market options	New markets emerge to support capacity outlook
Commercial outlook	Ongoing price erosion but not crushing impact
Summary	More of the same: competitive markets and players

- Our base case scenario is really an extension of the last 5 years of history
  - Moderate price declines
  - Slow migration of technologies and players though OLED and QD seem established as key trends
  - Some flexible product innovation
- Our general belief is that only some of the Gen 10s currently being thought about will come to reality
- We believe that the current glut of capacity going into OLED will cause some medium term turmoil to that market place
- Already a number of industry leaders are emerging (LGD, SDC, BOE, CSOT and the Foxconn cluster): these are players with the clout to be able to influence technology development agendas. BOE's technology direction seems confusing – trying to do a little of everything
- The winners here are the winners over the past two decades: the equipment companies and the materials players and consumers
- The losers are the smaller display companies
- This is likely our best guess of the outcome but the industry has proved in the past proclivity towards the other scenarios

Source: HCL

Scenario 2: The Best case is one with reduced capacity expansion, tiers of suppliers and differentiated market strategies

	Best case Tech future
Capacity outlook	Only 1-2 Gen 10s and Gen 7s find new markets
Technology outlook	QD, OLED and other new technologies thrive
Players and leaders	Leading set emerges and niche options for others
New market options	Autonomous vehicle display and other markets emerge
Commercial outlook	Prices more stable and everyone enjoys
Summary	Best case outcome with money for technology

- In the best case outcome then limited new Gen 10 capacity is coming online and that means that the Gen 7 capacity put under pressure may have the time to find and serve new applicable markets
- In the best case prices and supply/demand are more stable
  - In the best case, there is enough for everyone and even the smaller players can have the chance to specialise in certain submarkets
- In the best case, new technology gets paid for – yes pricing is higher for consumers but they then get to receive rich high end technology
- The winners in this case are the display companies and high end consumers who get to enjoy high end technology. Innovative materials firms do well and there are options for new equipment to meet specific needs
- Overall this might be a good outcome for number of players

Source: HCL

Scenario 3: The worst case has capacity explosions and drops in profitability and pricing across the board

	Worst case Capacity chaos
Capacity outlook	Large amounts of Gen 10 capacity (> 700k/mo) and Gen 6 oversupply
Technology outlook	Technology appears but it commoditised rapidly
Players and leaders	All players try to remain in head on competition
New market options	No significant new markets to soak up demand
Commercial outlook	Rapidly falling pricing in all markets
Summary	Dire commercial picture for all players

- The worst case has a large glut of excess capacity due to many Gen 10 fabs arriving and ramping solidly
  - Causing distress to the pricing in all large panel markets
- Moreover the OLED pile in also gives oversupply in those markets causing pressure everywhere
- In this situation prices are low and depressed everywhere
- The only winners are the equipment makers. Materials companies do OK as long as they can cope with making up lost margin with additional volumes
  - Display player have depressed margins and some exits seem likely
- Consumers benefit from cheap displays but not clear that an innovation agenda is being supported unless paid for by big brother companies like Apple
- This scenario becomes more and more likely the more that display companies pile into these very large Gen 10 fabs

Source: HCL

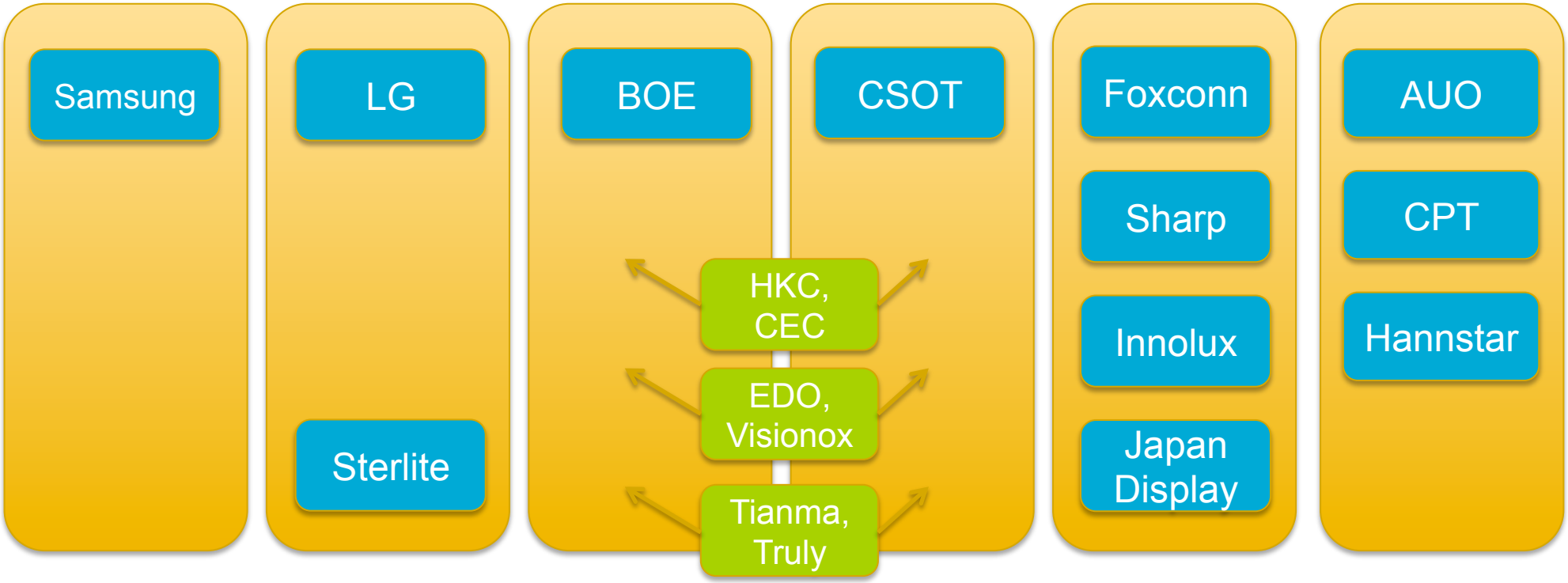
Scenario 4: The Consolidation case has the industry fall into groupings and hence behave semi rationally

	Consolidation case
Capacity outlook	New capacity arrives but industry consolidates
Technology outlook	Each of the leading clusters supports 1-2 technologies
Players and leaders	4-5 major groupings emerge overall
New market options	Samsung, LGD and Foxconn build new markets
Commercial outlook	The top 5 grouping do well, others suffer
Summary	The top groupings win (top 5 groups) pricing more stable

- Each of the major down cycles of the display industry has seen some consolidation activity
- We wonder in the next major down turn (likely 2019+) as the Gen 10s arrive whether we see more consolidation or exits
  - We wonder what will happen to the smaller Taiwanese and Japanese players (small Koreans already out)
- Already interesting that for both LG and SDC OLED represents a big portion of their future
- Winners in this scenario are members of the top groupings and their related suppliers. Losers are all the other smaller firms. This case may provide a little more industry stability and provide a platform for display innovation

Source: HCL

Scenario 4: In this case we might see some truly leading groups and then all others suffer



- Not clear what will happen to the other players
- We wonder whether the Chinese government changes the way that is deals with entrants and players in the display industry – perhaps coming down to a few groupings overall, for example 2-3
- There has been repeated talk of further consolidation in Taiwan but too many family and other corporate ties: however will economics finally push the smaller pieces in Taiwan together?

Source: HCL

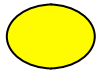
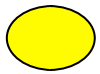
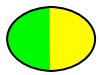
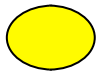
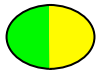
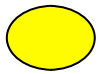
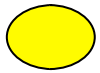
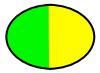
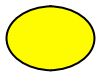
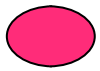
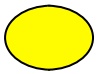
Scenario 5: The other downside option is one where only two major technologies dominate: a-Si and OLED and others fall away

	OLED and a-Si plus big brothers
Capacity outlook	Ongoing OLED growth and a-Si remains important
Technology outlook	Only OLED and a-Si thrive: QD fails and others fail
Players and leaders	LG, Samsung, BOE CSOT lead OLED and others focus on a-Si
New market options	OLED markets thrive with a-Si for the rest
Commercial outlook	Weak but not horrible pricing Big brothers support R&D
Summary	A weak option where only two technologies thrive

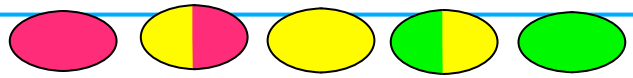
- This is another of our "semi-downside" outlooks for the health of the display players
  - In this case only two major technologies dominate – OLED and a-Si
  - Players with LTPS or QD strategies suffer as do the owners of oxide fabs
- The only innovative R&D happens either within the dominant technologies or paid for for a "Big brother" company such as Apple
- The list of total players may then divide up between the OLED owners and those without – the haves and the have nots. This scenario reduces the scope of future display R&D

Source: HCL

Implications of this scenario thinking on individual display players:

	Base Case: Competitive markets	Worst case Capacity chaos	Best case Tech future	OLED and a-Si plus big brothers	Consolidation case
Samsung					
LG Display					
BOE					
CSOT					
Foxconn-Sharp-Innolux-Century					
CEC-Panda					
Japan Display					

- On the whole the display leaders do better in all scenarios and are more resilient in the downside cases
- The capacity chaos outlook kills pricing and makes the future bleaker for everyone
- The big groupings do the best in the consolidation case

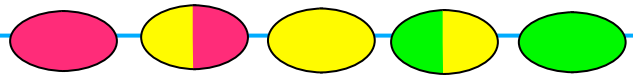
Less favourable  More positive

Source: HCL

Implications of this scenario thinking on individual display players:

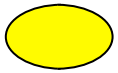
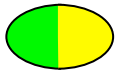
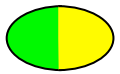
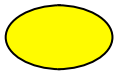
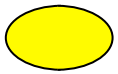
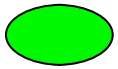
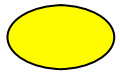
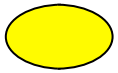
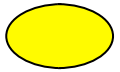
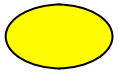
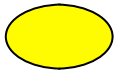
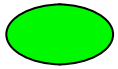
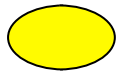
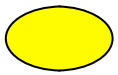
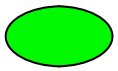
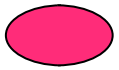
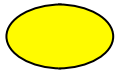
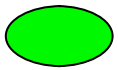
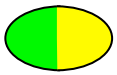
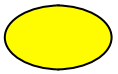
	Base Case: Competitive markets	Worst case Capacity chaos	Best case Tech future	OLED and a-Si plus big brothers	Consolidation case
AUO					
Truly					
CPT					
EIH					
Hannstar					
Tianma					
Sterlite					

- The smaller players of course do worse in all scenarios than the leaderboard
- EIH is somewhat immune to most of the changes having a very different company strategy
- Sterlite here we assume to be protected in its local Indian market

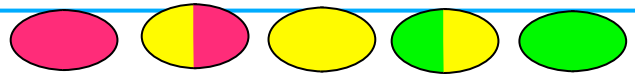


Source: HCL

Implications on key materials and equipment players:

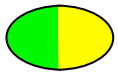
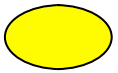
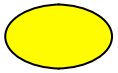
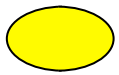
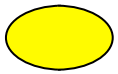
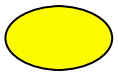
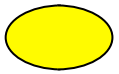
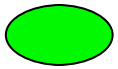
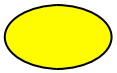
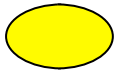
	Base Case: Competitive markets	Worst case Capacity chaos	Best case Tech future	OLED and a-Si plus big brothers	Consolidation case
Corning					
Merck					
Polariser + Film					
OLED materials					
QD materials					
Equipment players					

- For the materials players the key issue is how their economics might relate to larger volumes at lower margins (in the worst case) or dealing with more powerful negotiation counter parties in the consolidation case

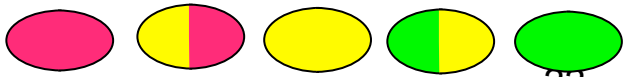
Less favourable  More positive

Source: HCL

Implications for brands and consumers

	Base Case: Competitive markets	Worst case Capacity chaos	Best case Tech future	OLED and a-Si plus big brothers	Consolidation case
Western high end brands (Apple)					
China brands and whitebox makers					
Consumers					

- For consumers of course the downside scenarios tend to give rise to cheaper products
- The more well off Western brands have an easier time being more isolated from changes in pricing and the ability to set out their own innovation agenda (and pay for it)

Less favourable  More positive

Source: HCL

Summary

- Back in 2012 we looked at scenarios for change for the display industry based on the hot topics then: AMOLED and oxide. We also looked at internationalisation and the role of big brother companies like Apple and Google
- Skipping forward to 2018, then AMOLED is assured and oxide there but not as solid as we might have thought
- Our new scenarios now are much more capacity driven (Gen 10, Gen 6 flex) and also reflect the changes in the display leaderboard (much greater role of Chinese players and their potential influence on the direction of the industry)
- We keep trying to think about ways in which rationality may return to the display industry. Samsung has shown some real strength in the last 2 years in their closure of the L7-1 line. On the flip side, too much capacity has been put into place for flex OLED and the Gen 10 rush has the potential to destroy value for all markets

- If you would like some more scenario based thinking to help you with your own strategy development, please contact us: ian.hendy@hendyconsulting.com

Source: HCL

Hendy Consulting Offerings:

Growth strategy	Performance improvement	Equipment and Capex	Sourcing strategy (Purchasing)
• Market entry strategy • Business unit strategy • Growth strategies for new technologies	• Product portfolio management • Pricing strategy • Cost reduction	• LCD/OLED factory capex decisions • Strategies for equipment makers	• Sourcing strategies, especially LCD and medical detectors • Make/buy decisions

Technology strategy and technology assessment	Partnering and alliances	Professional advisory and business planning	Strategies for materials providers
• Market and commercial strategies for new technology businesses • Market tracking services for corporates monitoring technology	• M&A candidates and assessments • Alliance formation support • Post merger integration planning	• Specialist insights for bankers, equity investors and other consultancies • Reviews of business plans and models (Strategic audits)	• Strategy support for materials providers in the FPD, SSL, and PV markets • IP and pricing plans

Source: HCL