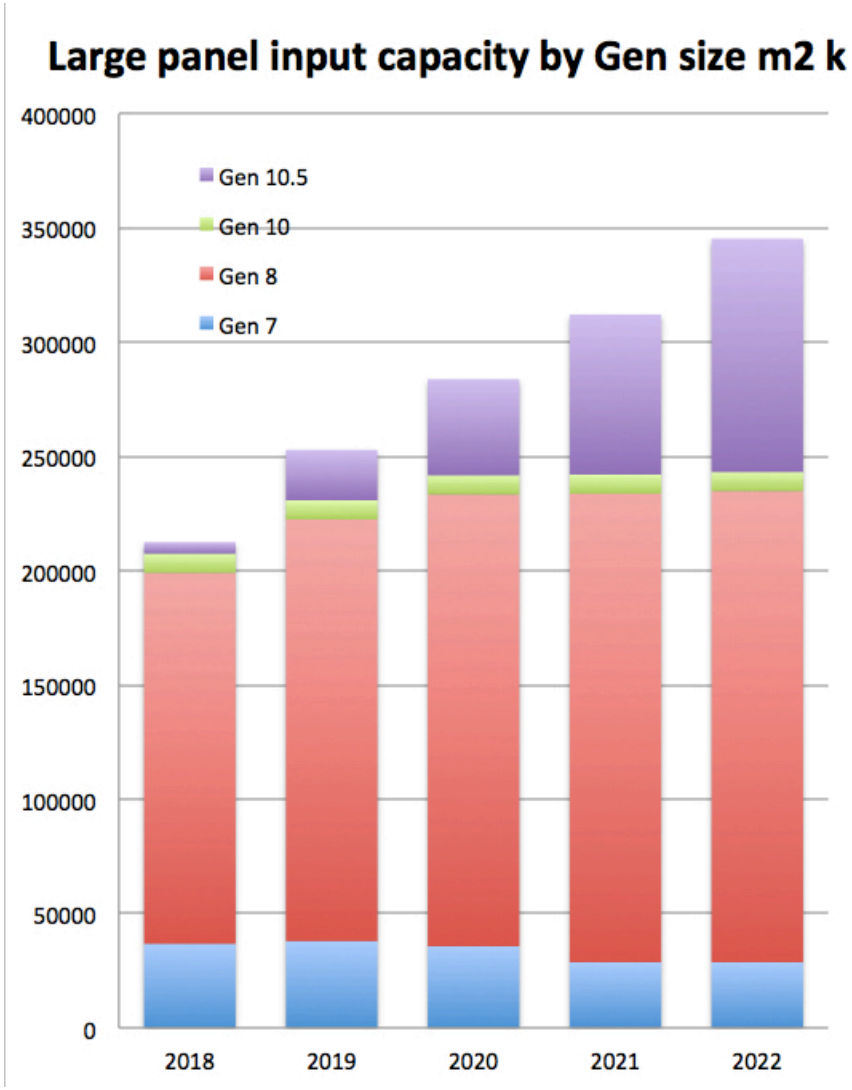
The impact of Gen 10 fabs on the display industry
Implications follow up

Ian.Hendy@hendyconsulting.com

Context: the Gen 10s are coming in a major way



- Gen 10 fabs only make sense when considering displays > 65 inch and are particularly strong for this (8 up, 94% efficiency)
- All of the following companies have been thought to be considering large Gen 10.5+ fabs: LGD, BOE, CSOT, Foxconn, HKC
- Frankly we find this roll out unprecedented with the large panel business potentially adding an extra 60% to the area of today's large panel business over only a small number of years. We are concerned that this "fungible" display capacity (that is can be reallocated to almost any production) could then reduce the economics of the factories that are smaller

Source: HCL based on IHS data

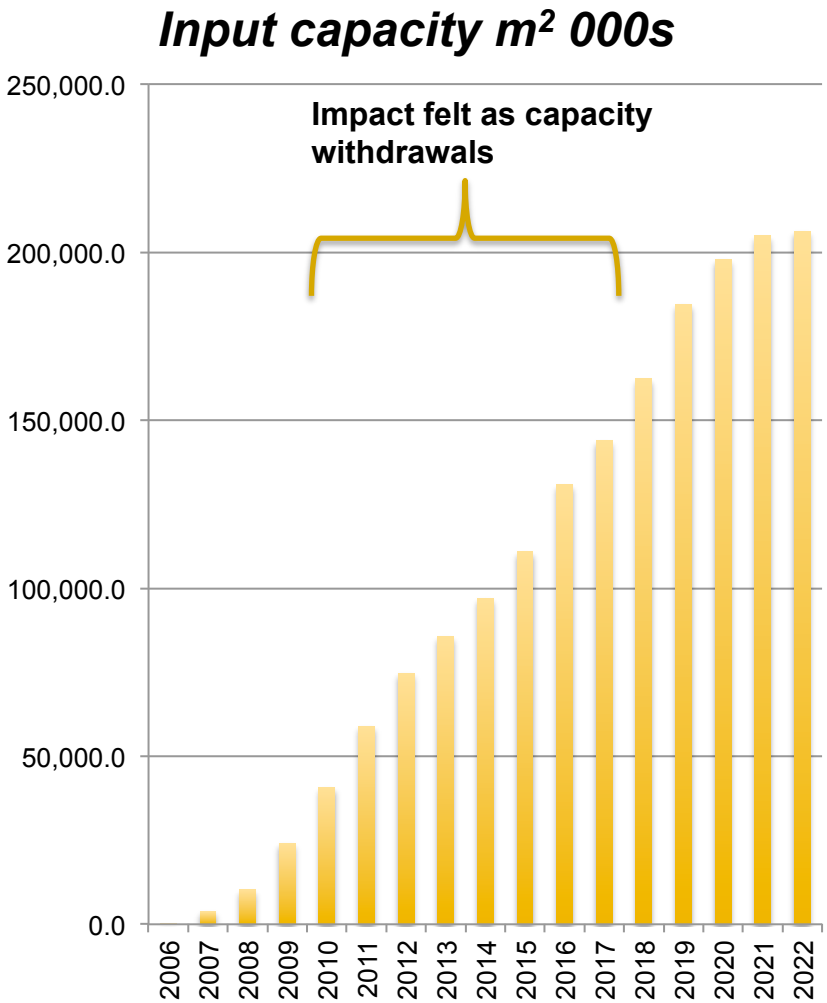
We discussed our own 10 factor model for considering the impact

1. Fab fungibility
2. Differential product strategies
3. Impact of large substrate on technology
4. Game theoretic implications and signaling
5. Previous case examples from Gen 8 era
6. Specific fab ownership patterns and load
7. Price elasticity
8. Options for lower gen fabs
9. New market creation
10. Leadership board changes

Impact of Gen 10 capacity

Source: HCL
http://informationdisplay.org/Portals/InformationDisplay/IssuePDF/03_2018.pdf
See page 18

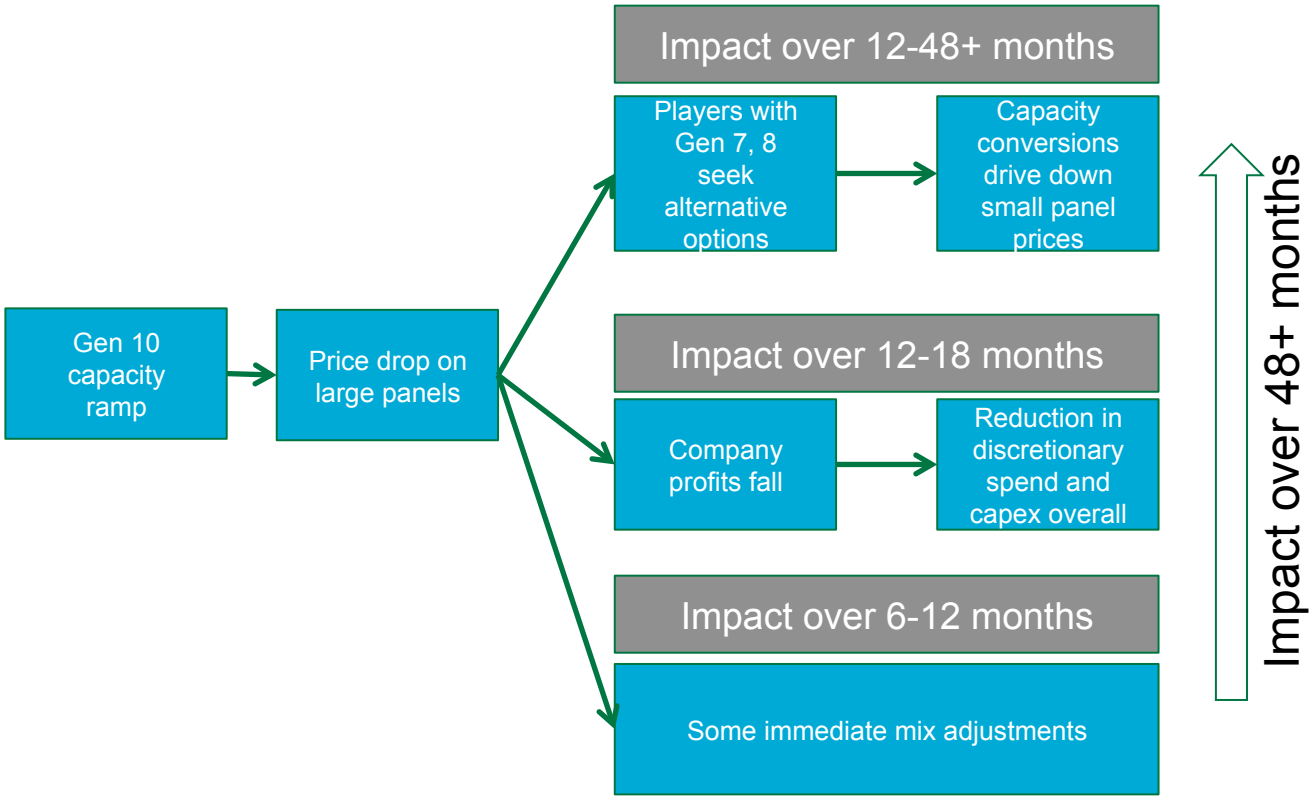
…and we used Gen 8 capacity as a case study: the impact was felt 2-10 years after introduction



- Let's go back and look at the period of the last major build up of capacity (2008+) for Gen 8
- The implication of this was the following impact
  - Pressure on Gen 2-4 fabs. First Gen 1/2 fabs started being withdrawn from 2008-2009 in serious numbers. Gen 3 fabs start being withdrawn from production from 2010 in serious numbers. Gen 4 start being withdrawn in serious numbers from 2016 onwards in serious numbers. Note that it does take quite a while for the impact to force closures
  - Price erosion of 32" and 40-42" panels in particular
- The insight here is an important one: massive waves of new capacity lead to factory closures *2-10 years later*

Source: HCL

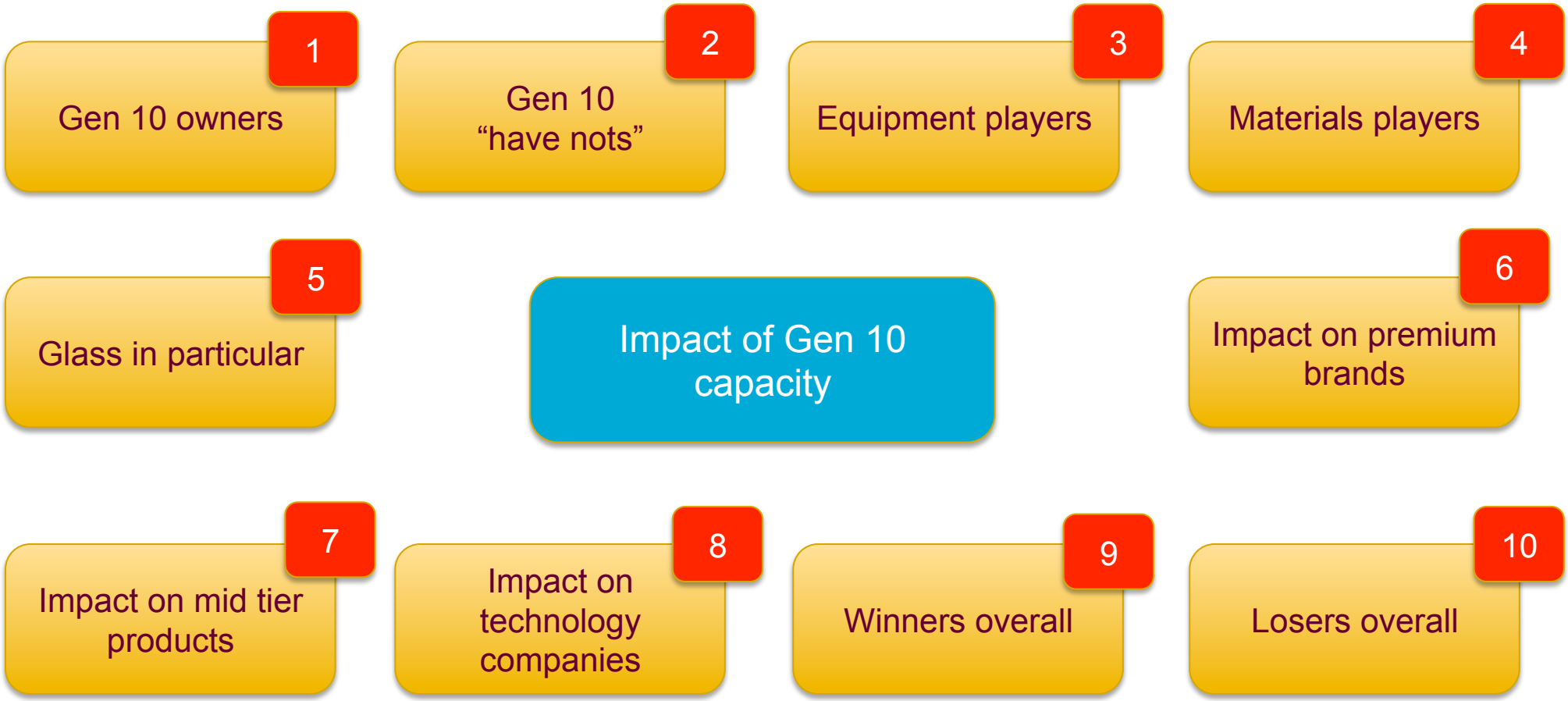
So actually we can expect the impact of the Gen 10s to continue well into the next decade. The immediate effect is a price drop of 65/75 TV prices, but then other markets start to fall too:



- This graphic describes the relatively short to medium term impact
- However, we expect the impact of Gen 10s to be felt right through next decade
- In the very long term we expect that very large numbers of smaller Gen fabs will close (may well be that there is very little below Gen 6 still productive)

Source: HCL

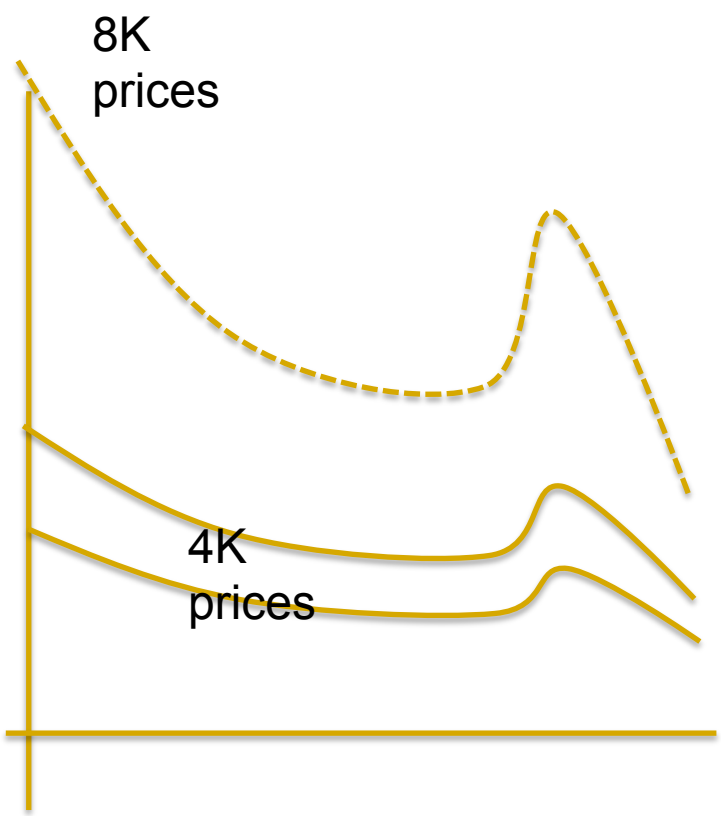
So now let's consider the implications for the industry: A new 10 factor framework



Source: HCL

1

What then will be the impact on the owners of Gen 10 fabs Timing is key

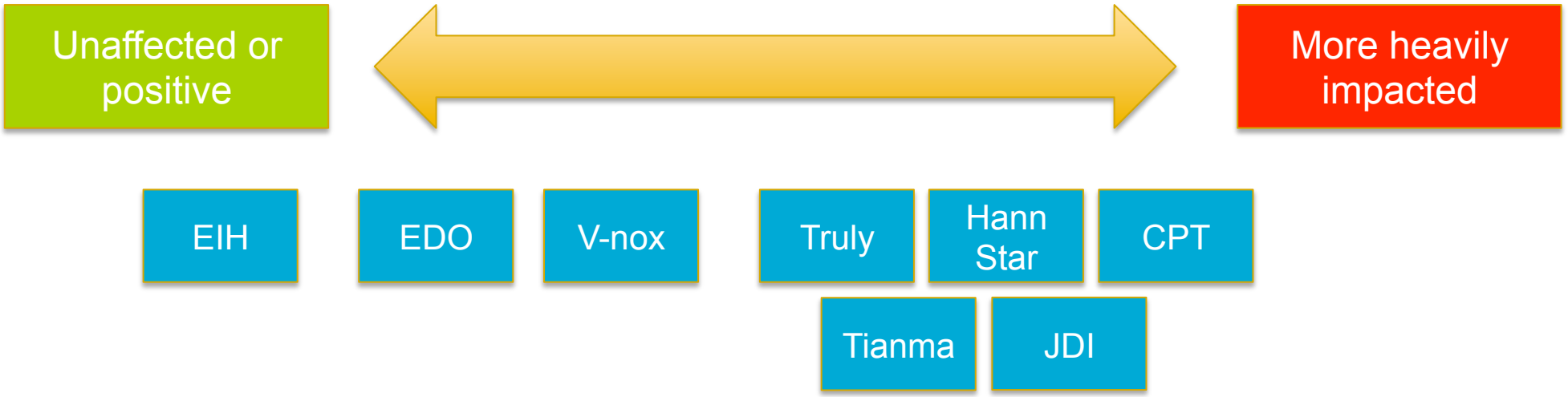


- The most critical economic issue for Gen 10 fabs will be about serving the 8K 65”/75” markets
  - Producing the panels in a way that works (decent yield etc)
  - Having access to branded channels that support the sales of high end TVs: otherwise the fab will be used to produce very large quantities of commodity TV
- Certainly we can see why the recent investment of the Foxconn group into Vizio in North America (one of the top TV sellers) makes sense
- The specific timing for the ramp for each fab will be critical
  - You want to ramp up into the best possible 8K panel pricing
  - It may be true that the later players will face worse economics than the first movers and the OLED movers may do better than the LCD Gen 10 owners

Source: HCL

2

What then will be the impact on the Gen 10 “have nots”: some players somewhat insulated from the chaos

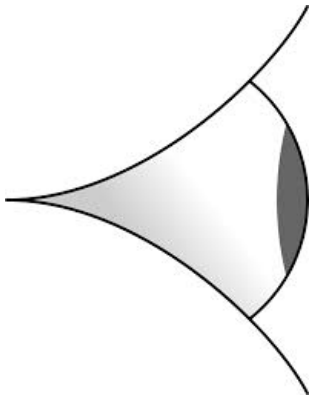


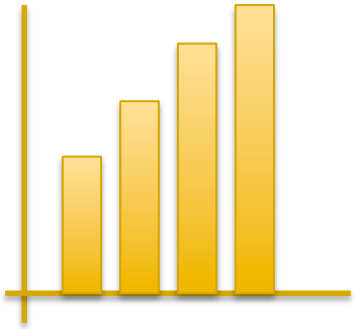
- In general we think that the impact of Gen 10 fabs will trickle down to many market places
  - That being said, some players through their market strategies may be quite insulated from the first order impact (e.g. EIH and the pure play OLED players and/or pure play small display market). What tends to happen is that players in multiple markets will move capacity from large panel into small panel or from LCD to OLED over a multi-year horizon: there will be a delayed impact. The conversion from large panel LCD to small panel is somewhat more simple to achieve than the conversion of LCD to OLED so we think the small panel LCD players more likely to be adversely impacted compared to the pure play OLED players
  - EIH is probably the most immediately insulated and in fact may be able to source arrays ore cheaply as a result of large panel oversupply

Source: HCL

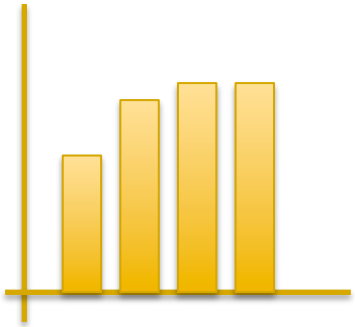
3

Overall the outlook is somewhat positive for the equipment industry, but you have to watch the real fabs vs the paper fabs





Upside case



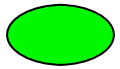
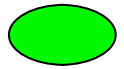
Low case

- Overall capacity expansion is a positive thing for the equipment industry
- However, judging which fabs are real and which are paper pipe dreams is very important
- Moreover, what goes up has to come down
  - The equipment industry forecast has always had peaks and troughs
  - Designing a business model that can cope with the upswings and downswings
  - Resisting customer attempts at customisation of equipment so that the equipment can be resold elsewhere
- Strong market sensing and market research capability will be important
- In particular Nikon has often been cited as the winner in litho for Gen 10 (the only player currently with Gen 10 litho gear)

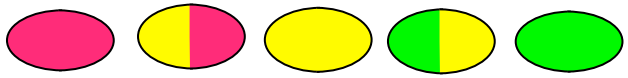
Source: HCL

4

Impact on the materials industry: largely will be determined by the market structure of each market and the impact of upcoming 8K. Volume outlook quite positive but price pressure will be tough

	Metals	Polarisers	Optical Films	Drivers	LC, PI and others
Volume Outlook					
Comment	• Need to drive large 8K displays likely to put pressure on continued innovation in metal lines (e.g. copper) but others	• Large expansion of display area on the whole a positive thing for the polariser industry • One wonders whether there will be more R&D into coatable polariser at the substrate level	• Likely an opportunity for all companies making areal films including the QDEF type films and others (DBEF, BEF, others) • Price pressure high	• 8K displays will have all the more rows and columns to address: so an opportunity for the driver and controller companies • Price pressure however may be high	• Again more large areas on the whole for the liquid crystal industry though there may be continued price pressure

- Need to drive large 8K displays likely to put pressure on continued innovation in metal lines (e.g. copper) and an opportunity for drivers. More large areas an opportunity for all the areal film companies



Source: HCL

5

Specific discussion on glass: AGC and Corning likely to do very well out of this

- It looks like AGC and Corning are the best placed to make business out of Gen 10 glass
- However, so far Gen 10 glass has not been easy to ship due to its size: Gen 10 glass fabs tend now to be co-located with display facilities
  - Corning has put down capacity in Hefei, and AGC in Guangdong province
- The investments in Gen 10 glass are very large (The Corning investment muted at $1.3bn) and it is pretty likely that the glass players can seek very strong supply deals or co-investments from each of the display players in each case
- The glass players in the past have been fairly damning about the Mutually Assured Destruction approach of the display players and capacity investments
  - It may be now that these players apply the brakes a little and that also glass prices rise (or the pace of price reduction falls)

Source: HCL

6 Impact on the high end brands by this:

Competing high end offerings

- 4K and 8K OLED
- 4K and 8K QD-OLED hybrids
- 8K LCD
- 8K LCD with QDEF or QDOG or QD CCL (Quantum Dot colour conversion)

- The challenge for the large Gen 10 fab owners will be in helping getting their products positioned at the high end
- Recent market data (NPD) shows the top 3 brands consolidating their control of the high end market
- There will be quite a number of competing value propositions for the consumer dollar
- For now LGD has done a very good job of positioning OLED with its ecosystem of brand partners and Samsung is on the back foot with its different QD approaches: 8K LCD will only make this a more cluttered premium sector

Source: HCL

7 Impact for mid to low tier brands in the TV space

- Suppressed pricing for mid sized TV panels
- TV brand margin recovery on percentage basis but pricing lower
- Need to move large volumes of mid-size TV
- Need to develop new channels and new geographies
- Trickle down of premium features into the mid tier

- We should see a massive increase in the availability of mid-sized panels at good prices
  - As a result the TV brands may be able to claim a little better percentage margins on product despite the fact that overall prices will be lower
- Mid tier brands may face the challenge of how to move all of this additional volume
  - New channels
  - New markets (at lower price points)
- We may see some of the more premium features coming down into the mid sized panels also over time

Source: HCL

8 Impact on technology start ups to the display space

Technologies that might be interesting

- Oxide or other approaches that give premium device performance
- QD CCL approaches
- 8K with associated driving
- Wet layer polarisers or other optical treatments at sheet level
- Simpler TFT pixel structures (or more premium approaches also)
- Ways that simplify the challenges of very large chambers and very large masks
- Technologies that help very large panels to be used for very large signage and for education

- Gen 10 may be an opportunity for start ups to bring new technology to the table
  - Will be a new platform for the next decade
  - What makes Gen 10 particularly difficult is the need for very large production equipment and associated co-located materials: are there options to make some of these pressures a little less?
  - Moreover, players with Gen 10 fabs will need to be able to grow new markets that will consume very large displays: this may result in hardware or peripherals or changes in materials to achieve this
- The numbers are very big in the Gen 10 era so the opportunities may also be commensurately large

Source: HCL

9

Winners will include the equipment companies, the materials companies with differentiated product

Winners overall

- Glass companies
- Anyone with unique technology where the price pressure can be abated
- Drivers companies may see large volume growth
- Nikon and equipment companies
- Some technology companies

Companies that may do well

- Corning
- AGC
- Merck
- Nikon

- The winners overall here will probably be the equipment companies (as long as they keep their eyes on the ball) and the stronger materials firms who have differentiated product
  - For other materials firms there may well be high volume growth but also high price pressure
- The glass players may do well since for now it looks like really only Corning and AGC will be in the market for Gen 10 borosilicate
- Some technology firms may also be able to gain out of the Gen 10 upside

Source: HCL

10

Losers

Losers overall

- Mid sized and larger display companies with < Gen 6 and Gen 7 and smaller Gen 8 fabs
- Materials firms with non-differentiated product
- Perhaps the later entrants into the Gen 10 race – depending on the exact evolution of 8K panel pricing

- The losers in this game will be most of the display companies especially those with older asset profiles
- Materials firms with non-differentiated product may find the pricing environment very tough
- Those players of course that have not scaled their technology to reach the sizes for Gen 10
  - Canon perhaps
  - Film players not yet scaled to be able to deal with the widths needed for 75"+ panels
- For us it is not yet a certainty that all those with Gen 10 fabs will make money
  - FCF economics of fabs are very dependent on mix and on the proportion and pricing of the premium offering (think about it like the utilisation of business class on an airline). Moreover the economics are heavily dictated by the cash flows achieved in years 2-5: if you get the timing wrong and ramp into lower pricing then the economics could be very poor

Source: HCL

Summary

- From our Gen 8 case study, then the impact of Gen 8s was a set of dislocations and fab closures over the following 2-10 years. This could well be the same for Gen 10
- We have chosen to break apart the display ecosystem into 10 areas for consideration from the Gen 10 owners and “have nots”, to equipment and materials companies
- While it is very difficult to foresee all of the dislocations that the display industry will suffer, we have tried to highlight some of the key complexities and issues that will be important
- If you would like us to think about what the implications might be for your organisation in more detail then please drop us a line: ian.hendy@hendyconsulting.com

Source: HCL

Our 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