



Indium: Is There Enough?

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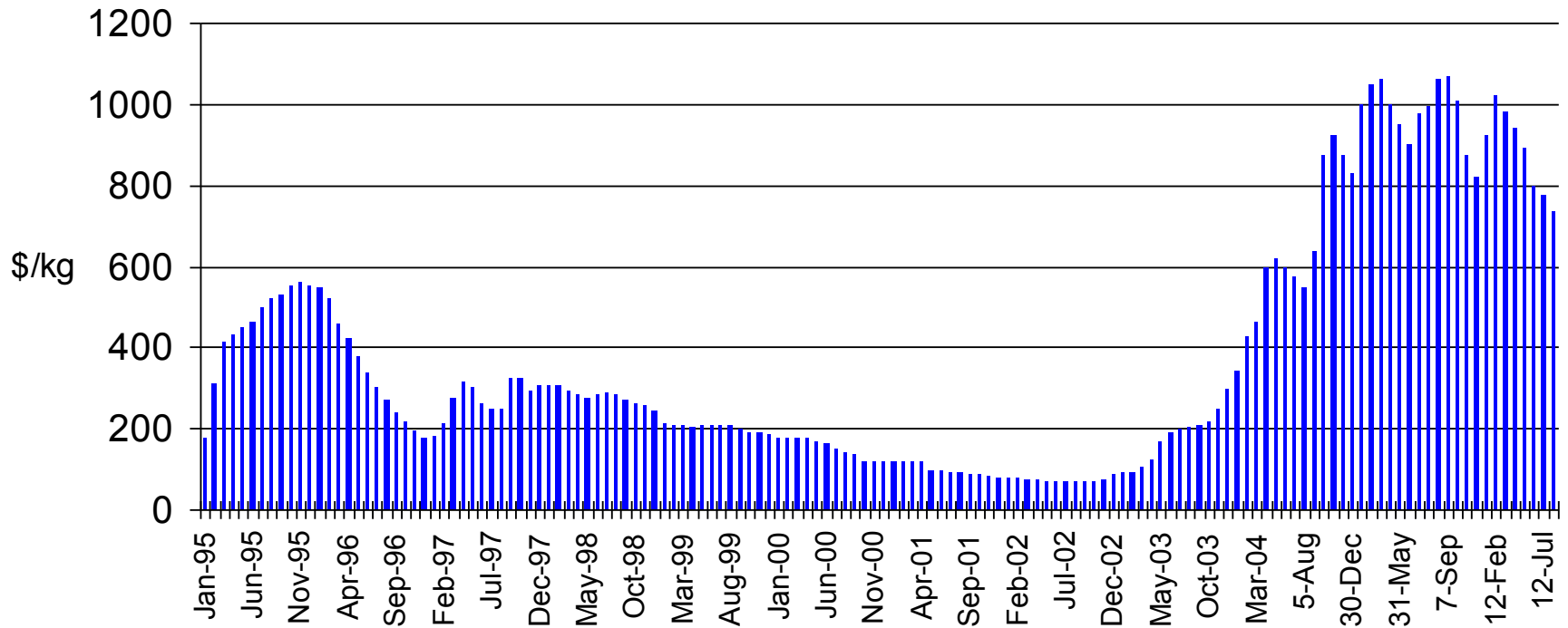


Overview of Topics

- Indium Price
- Demand by end use
- Trends: Existing + New Applications
- LCD Demand: Indium Based Transparent Conductors (ITO)
- Can ITO be replaced?
- Conclusions



Indium Price: January 1995- August 2006



Brian O'Neill

AIM Specialty Materials

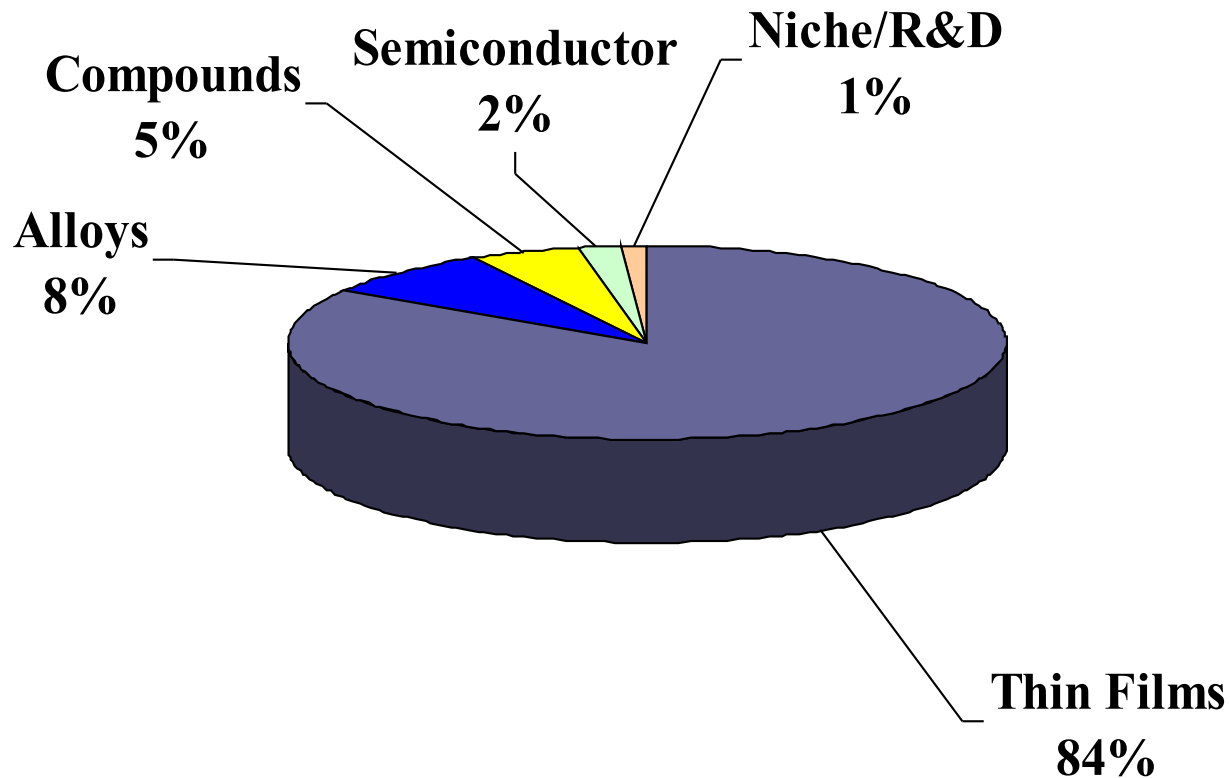


Price decline: Why?

- Q2 LCD demand was below forecast
 - LCD fabs overbought all materials in Q1
 - Working back through the supply chain
 - Destocking (fabs & the trade)
 - Temporary
- ITO Recycling
 - Impact now ~ normalized
- Q3 to Q4 expected to be strong
- *Underlying fundamentals remain very strong*



Indium: Consumption by End Use





2006 Demand: 1,208T

- ITO: 1,008
- Alloys: 100
- Compounds^{**}: 65
- Semiconductor 17
- R&D 18

^{**} Alkaline dopants, MOCVD precursors, microwave garnets



Supply / Demand Balance: Factors

- **Positive Factors**
 - Recycled Indium now $>$ primary
 - Improved Yields at TFT-LCD fab's.
 - Stockpile “buffers”
- **Negative Factors**
 - Demand Growth $>$ production growth
 - Instability of primary production
 - New Uses for In despite price/supply issues



Indium: Estimated Supply/Demand

	2003	2004	2005	2006	2007	2008
<i>Primary Indium Production</i>	400	380	380	410	450	500
<i>Indium from Recycled ITO</i>	210	294	441	605	847	1101
Total Supply	610	674	821	1015	1297	1601

<i>Indium Demand: ITO Targets</i>	350	490	720	1008	1411	1835
<i>Indium Demand: All other</i>	163	189	200	200	210	210
Total Demand	513	679	920	1208	1621	2045

Surplus/deficit	97	-5	-99	-193	-324	-444
%of Indium related to ITO:	68%	72%	78%	83%	87%	90%
Cumulative surplus/deficit	97	92	-7	-200	-525	-969



Factors Impacting Growth

- **Microsoft Windows:** Vista operating system hits market Q1 2007^(a.)
 - new operating systems = burst of computer demand; Most will have LCD displays
- **LCD-TV Market Growth:** Glass demand:
 - 800million ft² in 2005^(b.)
 - 1.4 billion ft² in 2007^(b.)
- **Larger panels** = more indium per unit sold

(a.) Wall Street Journal, 4/13/06, "Annual Buying Guide: How to Ensure New PC can use Windows Vista", Walter S. Mossberg

(b.) Corning (GLW) Press Release, "Corning Provides LCD Glass Market Growth", Corning, NY February 3, 2006



LCD Market:

Growth & Impact on Indium

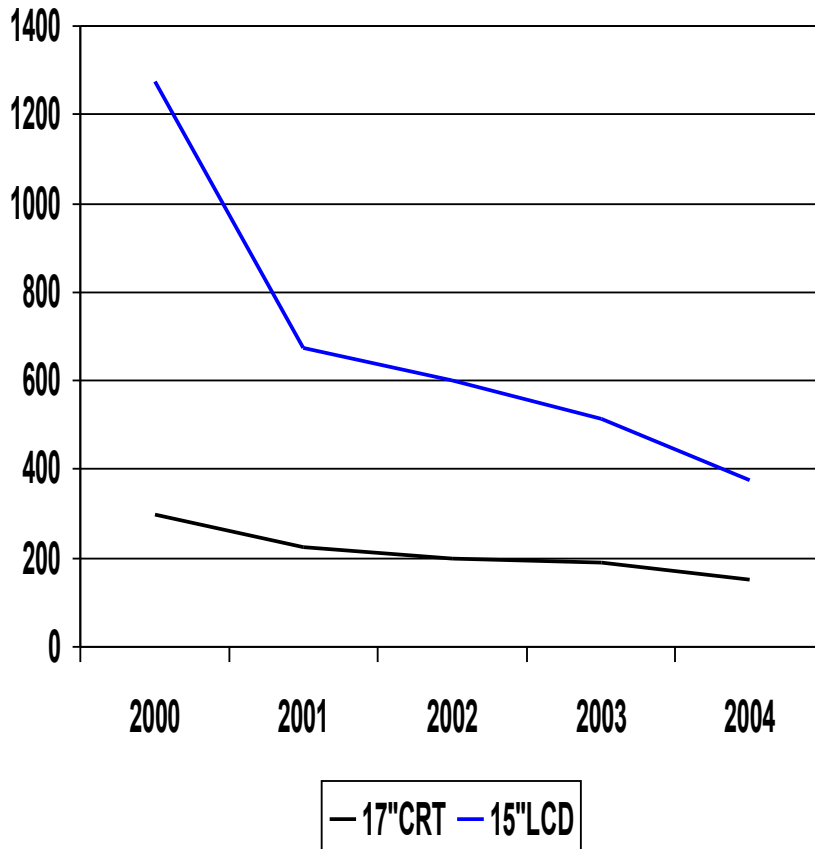
LCD: 3 waves of growth:

- 1. Mobile Electronics:** (*Laptops, Cell Phones, PDA's*): Boom/Bust Cycle, late 1980's to mid 1990's
- 2. Desktop Monitors:** Mid-1990's to present
- 3. LCD-TV:** early 2000's to present

We are still in the early phase of the LCD-TV growth curve.....



LCD vs CRT: Desktop Monitors



LCD Market Penetration vs CRT:

- 2000: 6%
- 2004: 53%

Source: Corning Presentation: The Emergence of LCD-TV and its Impact on Glass, January 10, 2006



Decline of CRT, Rise of FPD

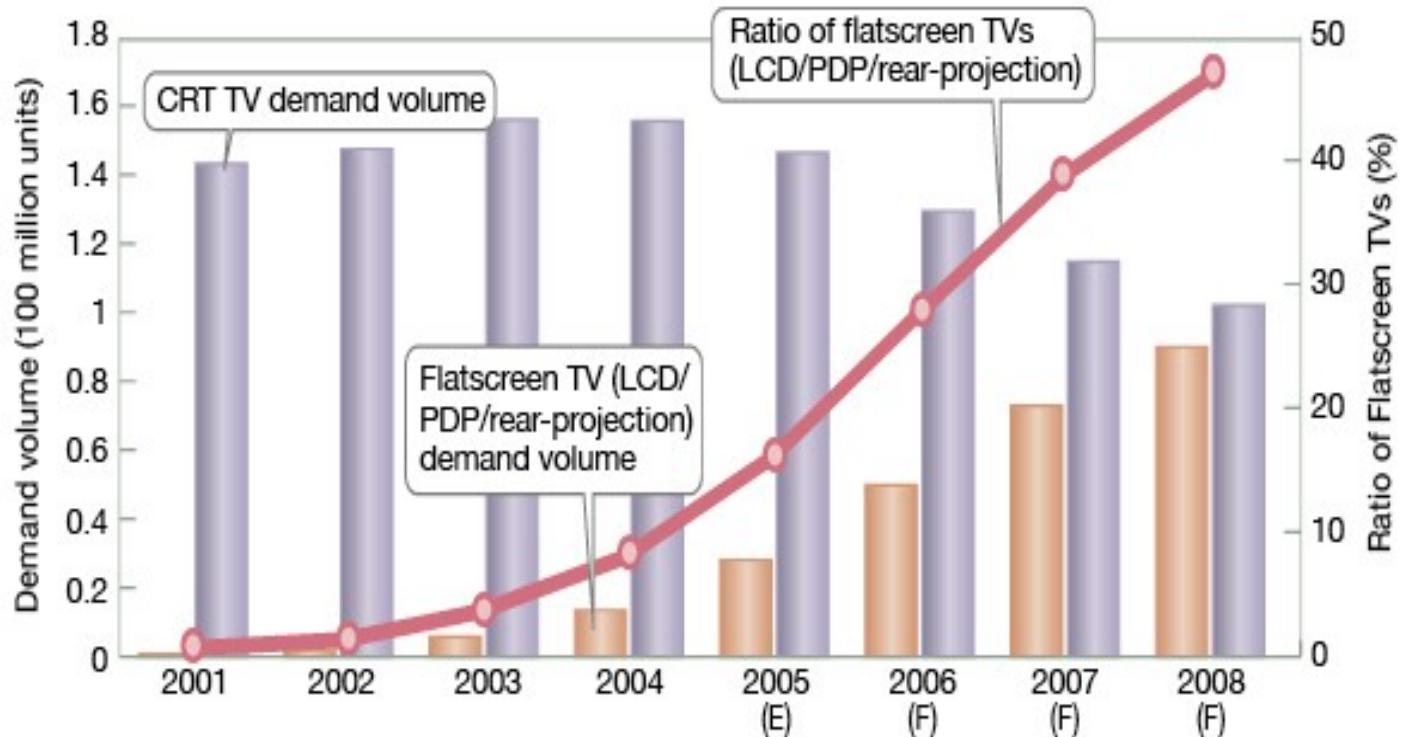


Fig 3 Flatscreen TV (LCD/PDP/Rear-Projection) and CRT TV Demand Volume, and Weight of Flatscreen TVs (Diagram courtesy Deutsche Securities)



LCD & PDP Demand

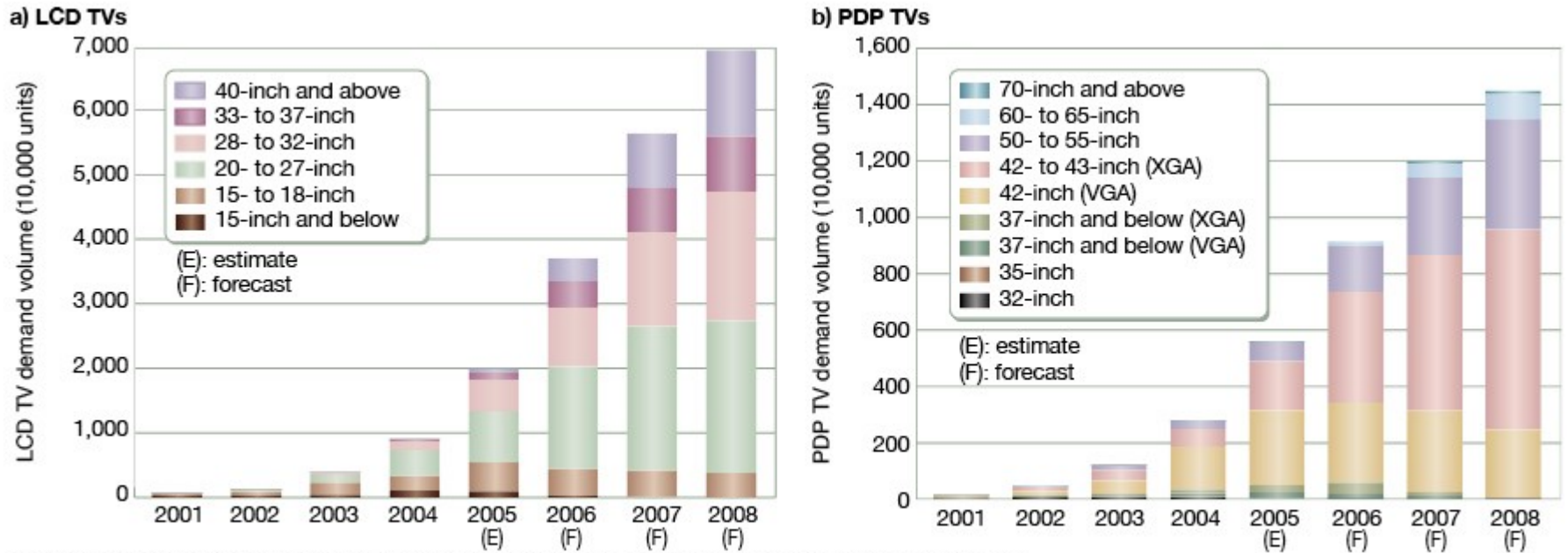
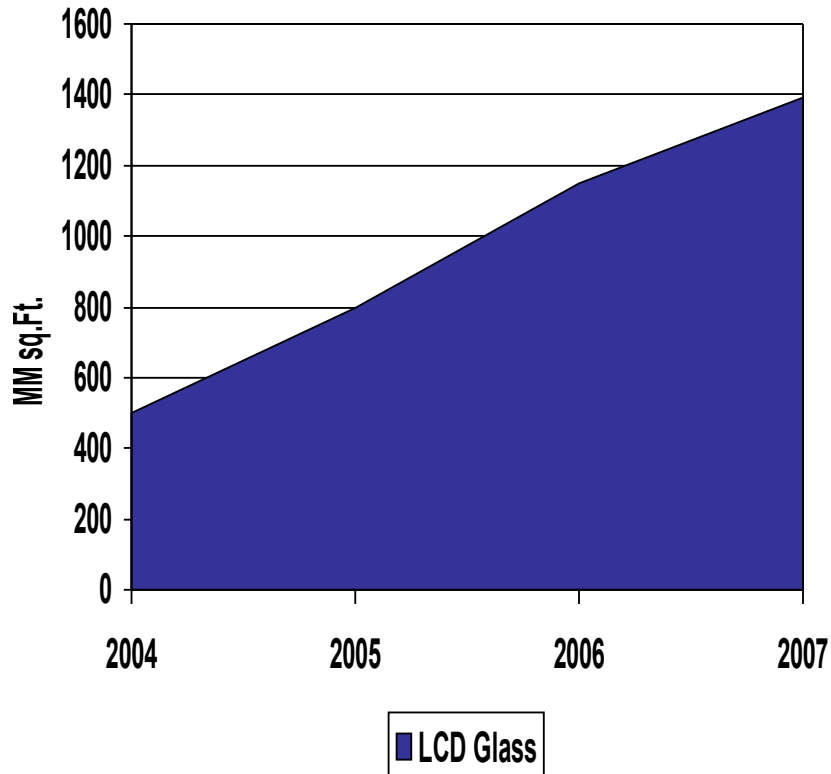


Fig 2 LCD/PDP TV Demand Volume by Screen Size (Diagram courtesy Deutsche Securities)

Source: Nikkei Electronics Asia, May 2006



Overall LCD Glass Market



- 41% CAGR: ('04 – '07)
- All requires an ITO coating

Source: Corning Presentation: The Emergence of LCD-TV and its Impact on Glass, January 10, 2006



Alternatives to ITO: Is it worth the effort?

Element	Approximate Cost (US\$/Kg)
Indium	\$ 725.00
Gold	\$ 21,000.00
Tin	\$ 11.00
Lead	\$ 1.25
Bismuth	\$ 12.00
Silver	\$ 400.00
Zinc	\$ 3.30



Structure of a TFT

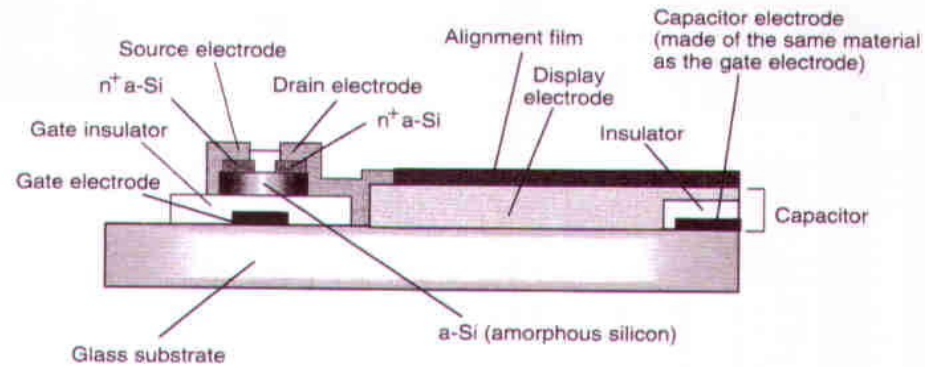


Figure 3.3 Cross-section of TFT array and pixel structure



Indium (ITO) Based TCO's for LCD:

Can/Will indium be replaced?

- ITO has optimal optical, electrical, and physical properties for LCD
- > 15 Year history of high volume production & reliability

***Productivity & yield drive profits at LCD
Fabs, ITO cost is insignificant***



LCD Costs: Indium a non-factor

Fabrication of an LCD:

- Similar to fabrication of a semiconductor wafer

Volume, Equipment utilization & defect yield dominate the cost structure

- Indium cost/panel < \$2.

Gen 4 Equipment: Four 17" panels per substrate
glass sheet (substrate)

Gen 5 Equipment: Twelve 17" panels per substrate

Gen 7 Equipment: Twelve 32" panels per substrate



LCD Fab Costs:

- Indium price does not matter
- Equipment utilization & yield % is everything!
- **Equipment down-time costs ~\$500./minute**
(= \$360,000. for a 12 hour target change-out)
- 1 meter² ITO target costs < \$90K once recycling is factored in



Bottom Line

- Growth in LCD glass demand: good proxy for indium demand growth
- Expect ~ 40%/year in the near term
- Does this hurt new applications?
 - *No. We are seeing new applications for indium every day.....*



Conclusions: Indium Supply Chain

- Mining: Concentrates (*inelastic*)
(Bolivia, Australia, Canada, China, Russia)
- Trading/Brokers
- Refiners
- Secondary fabricators: ITO targets
- End users (*inelastic*)

Problem: Indium remains a minor metal



Conclusions

- **ITO Demand:** Will grow in step w/ LCD
 - *ITO Will not be replaced in the near term*
 - *Improvements in Target Utilization may help stretch the supply*
- **Primary Indium Supply:**
 - *Reliant Upon Zinc*
 - *Prone to supply shocks*
- **Recycled Indium:**
 - *Has Kept market out of deficit so far*
 - *All ITO that can be recycled is being recycled*



Conclusion

Indium: Is there enough?

- Possibly
- Depends solely on ITO recycling, however:
- Primary/Recycling ratio is upside down
 - Annual Indium produced from recycled ITO is far greater than annual primary production.....this is untenable