

450mm : A Wafer Manufacturer Perspective

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MEMC



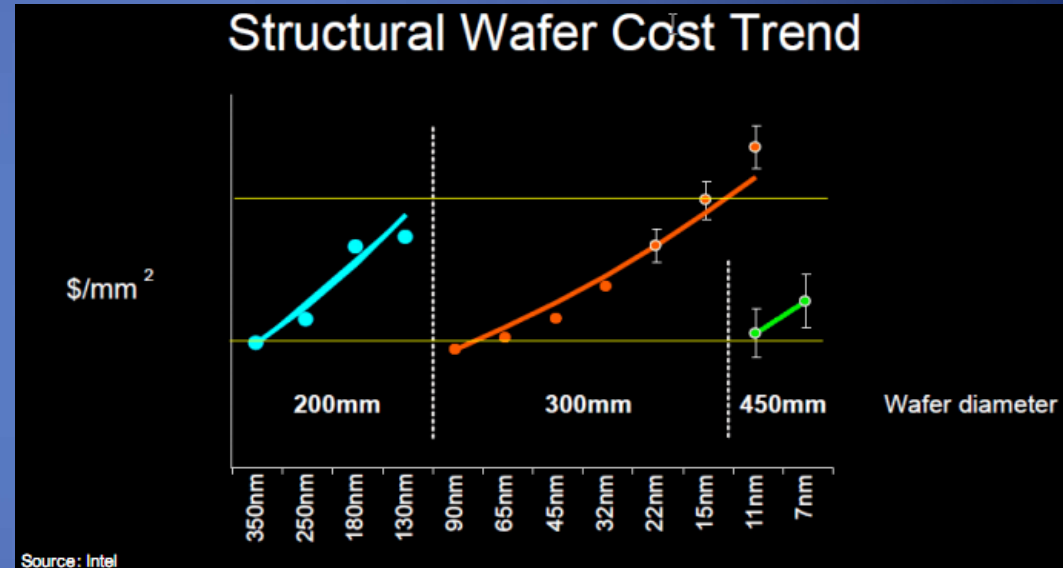
Agenda

- ❑ 450mm Rationale from the Device Maker Perspective
- ❑ Wafer Supplier Industry Status
- ❑ 450mm Wafer Supplier Perspective

450mm Rationale from the Device Maker Perspective

Cost Aspects

- ❑ Increased Number of Devices per Wafer
- ❑ Lower Manufacturing Costs
- ❑ Lower Labor Cost per Wafer
- ❑ Lithography availability debate : influences timing but not the necessity for diameter move



The transition to 450mm is supported by arguments similar to the 300mm transition

450mm Rationale from the Device Maker Perspective

Competitive Aspects

- ❑ Displace Competition ... only the largest, profitable ones can afford
- ❑ After Tier 1 adoption of 450mm, what strategy for Tier 2 ?
- ❑ Concentration in the Semi Industry, more large scale M&A
- ❑ Some Tier 3 move to Fabless

Potential 450mm Fab Owners		
Definite and Early Adopters	Will Be Forced to Follow or Fail	Long Shot Fab Owners
Intel Samsung TSMC GlobalFoundries	Toshiba Hynix Micron/Nanya/Inotera Elpida	UMC SMIC IBM*

Source : IC Insights

The transition to 450mm may substantially reshape the Semi landscape and lead to disruptive scenario

450mm Rationale from the Device Maker Perspective

Key Challenges

- Unclear timing for 450mm transition
- At what node ?
- Which transistor Architecture ?
- Advanced Lithography Availability ?
- Tool Availability ?
- Starting Material ?

- **Although volume driven, the transition to 450mm includes many economic and technical challenges**
- **Strong necessity for cooperative approach - G450C**

Wafer Supplier Industry Status

Recent Announcements

□ Siltronic

- Adapts Capacity for 150 Millimeter Silicon Wafers to Market Demand (March 2012)
- In light of the lower expected volumes of 200mm wafers, decided to close the plant in Hikari, Japan (January 2012)

□ Sumco

- Workforce reduction by 15% or ~1,300 employees
- Close some 150, 200 and 300mm plants (February 2012)

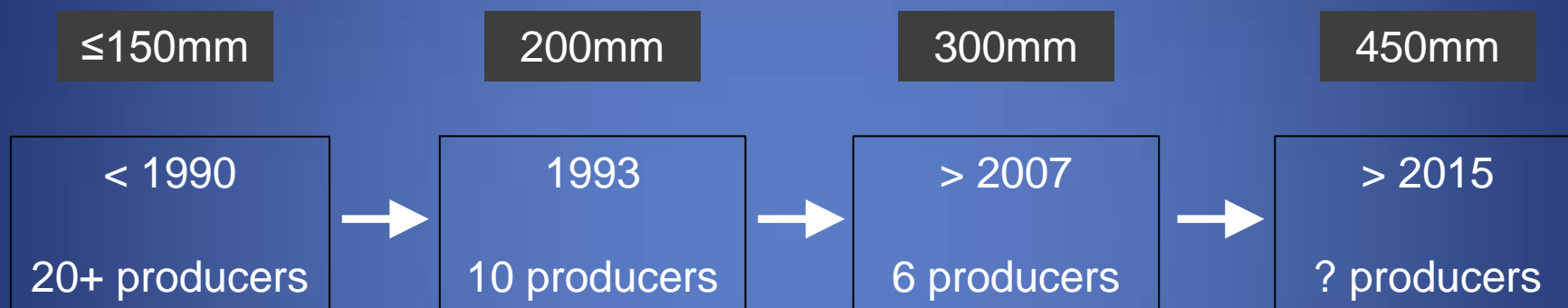
□ MEMC

- Semi workforce reduction by 11% (December 2011)

The Silicon industry is adapting to the market evolution and will cautiously invest in capacity and capability

Wafer Supplier Industry Status

Competitive Landscape - Consolidation

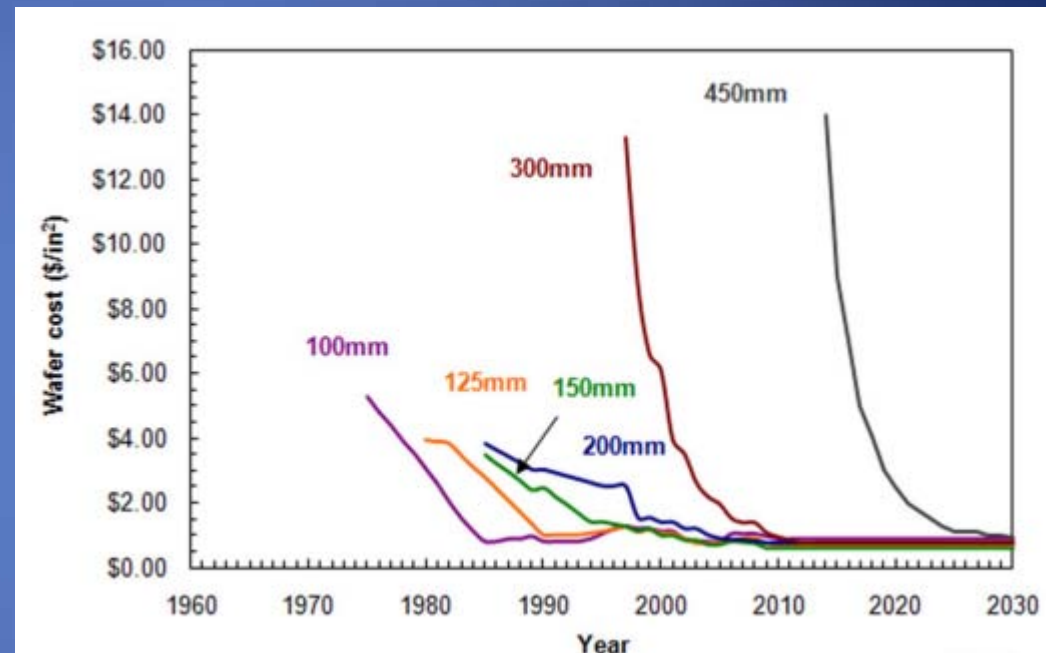


How many (profitable) wafer suppliers will be left and are needed for 450mm ?

Wafer Supplier Industry Status

Price Curve

- ❑ Previous diameter generations have all reached pricing maturity
- ❑ Rapid pricing decline
- ❑ No extra pricing available to fund 450mm development
- ❑ 450mm will represent a very minor fraction of silicon demand by 2015-2016 (about 1-2%)



Source : IC Knowledge

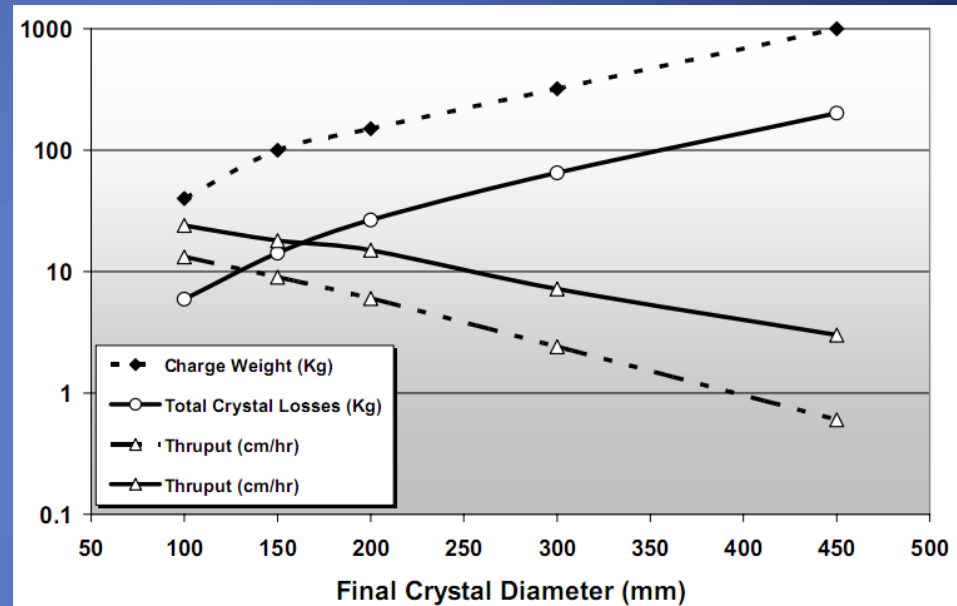
In order to be profitable, wafer suppliers need to enter 450mm wafer production at the right time with the right mindset

Wafer Supplier Industry Status

Cost Considerations

□ Increased cost (Si equiv.) for 450mm ?

- Increased thickness (increased cost per Si volume)
- Increased equipment cost with lower throughput (crystal pullers, epi reactors...)
- In proportion vs 300mm :
 - more epi vs polished
 - more usage of complex structures (SOI, III-V...)?



Source : White Paper ITRS 450mm

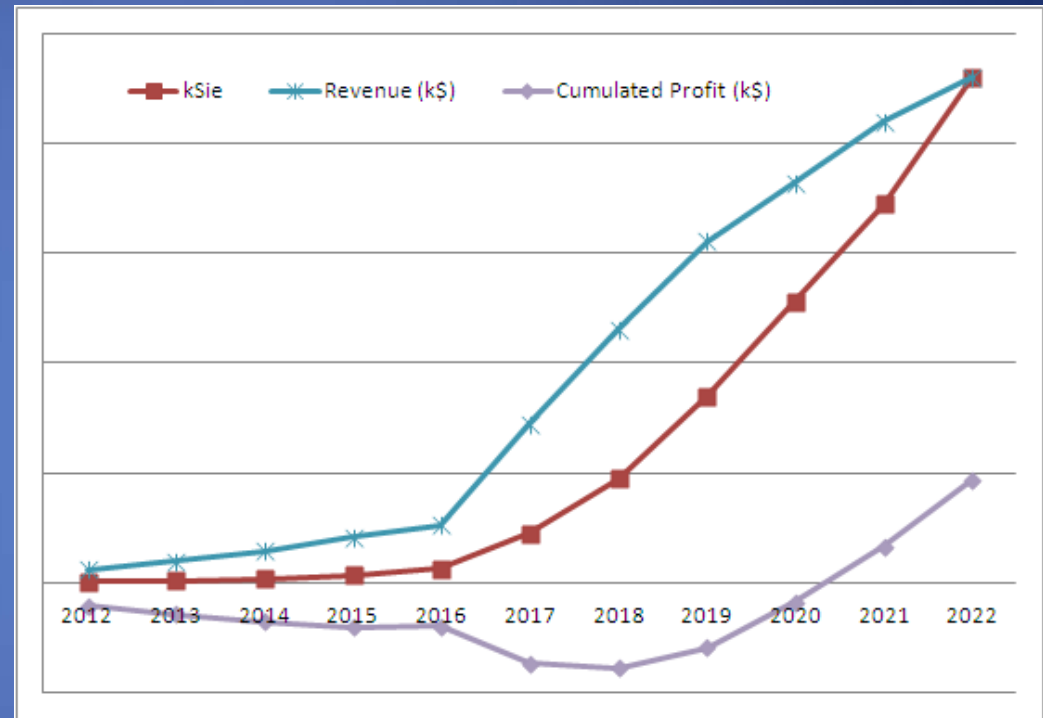
The cost per unit surface does not necessarily decrease when moving to 450mm

Wafer Supplier Industry Status

Payback Considerations

□ Assumptions :

- CAGR (kSie) ~5%
- Cross-over with 300mm volumes in 2022
- Degressive ASP from >12\$/Sie in 2012 to 1\$/Sie in 2022
- Decreasing margin and spending as % of revenue per year



Source : MEMC estimates

Simulations show wafer maker losing money until 450mm is close to reach maturity

450mm Wafer Supplier Perspective

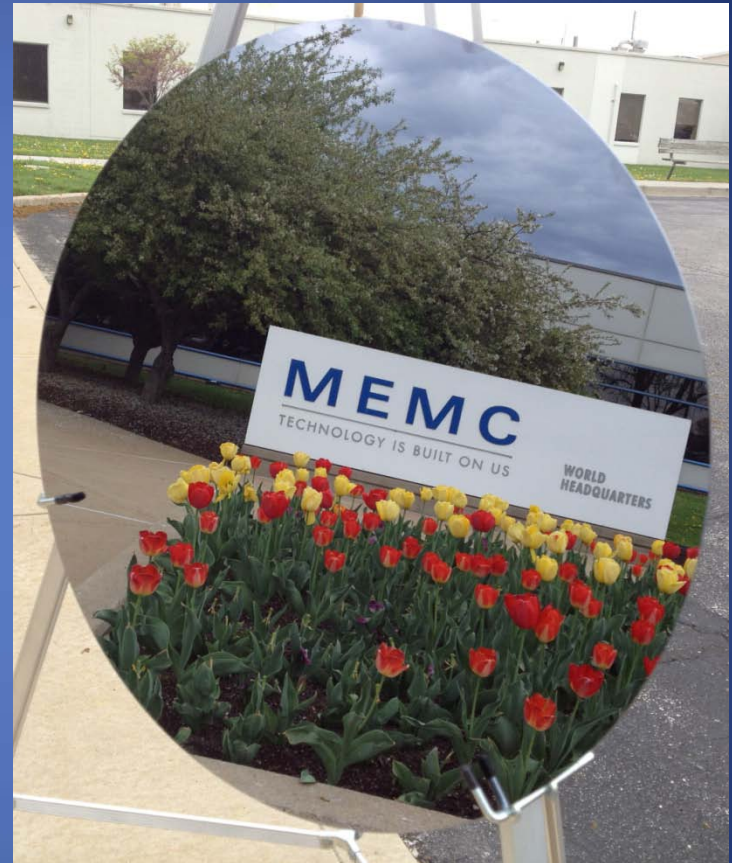
Standardization

- ❑ SEMI helps define standards
 - ❑ SEMI M1-1111 - Polished Single Crystal Silicon Wafers
 - ❑ SEMI M74-1108 - Mechanical
 - ❑ SEMI M76-0710 - Developmental
 - ❑ SEMI M80-1111 - FOSBs

- ❑ ... but the previous diameters (including 300mm) teach that nearly every user wants his own specificities :
 - Lasermak
 - Edge Profile

- ❑ Lack of flexibility

- ❑ Extra costs for the silicon suppliers



Use the 450mm diameter as a new platform to achieve actual Standards

450mm Wafer Supplier Perspective

Timing

- ❑ No significant technical hurdles foreseen to achieve 450mm prime wafer quality
- ❑ Mechanical wafers readily available
- ❑ Test wafers being made available however facing metrology limitations
- ❑ The timing is defined by
 - Cost and ROI considerations
 - Equipments availability (edge grinder, polisher, cleaning bench, epi reactor...)
 - Metrology availability (particle, flatness...)

Need close cooperation among consortium, final users and the material suppliers to optimize cost and availability

450mm Wafer Supplier Perspective

MEMC Activities



450mm Crystal pulled



Single Wafer Carrier on Tools for DSP of 450mm Wafers

**MEMC is in a position to support the 450mm transition
in a timely manner**