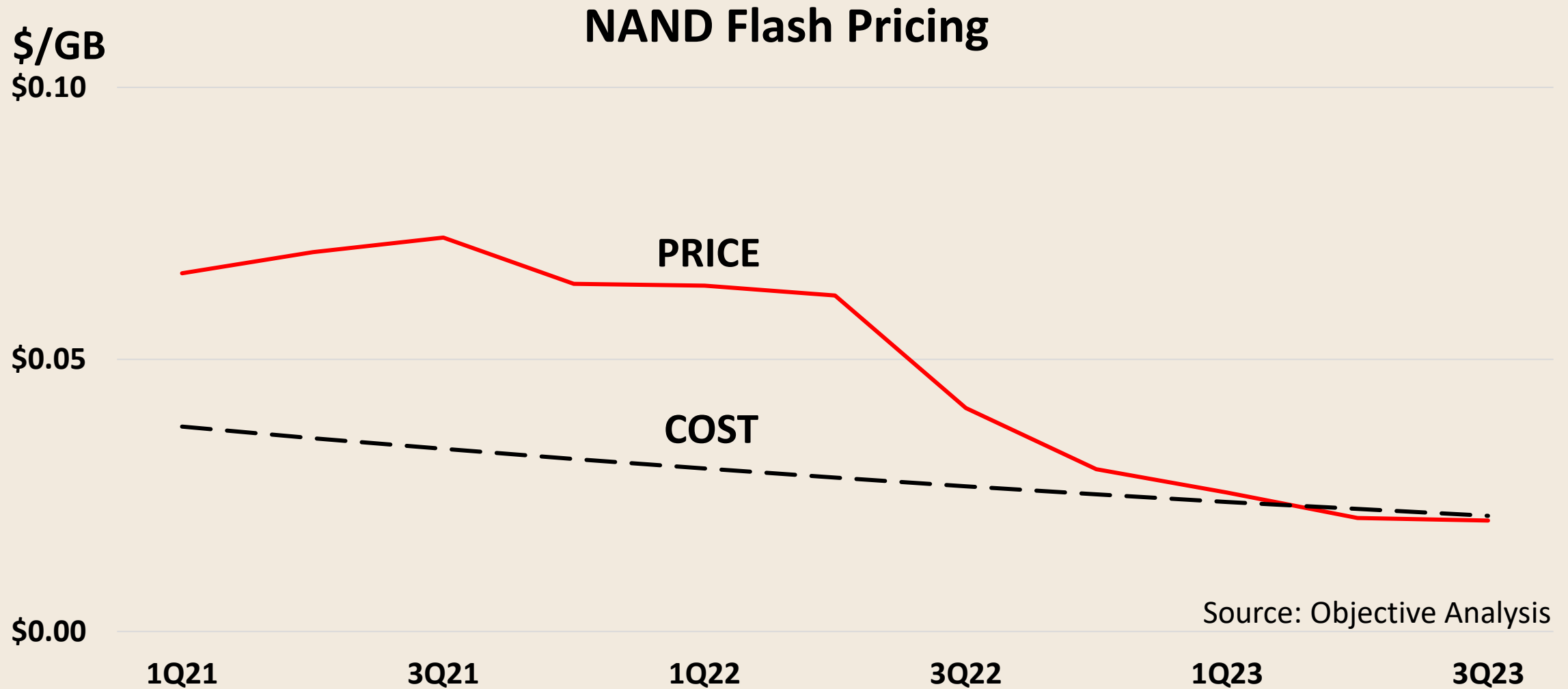


# Is Flash Doomed?

Presenter: Tom Coughlin, President  
Coughlin Associates

# Today's Collapse



# What Happened?

The industry was hit by a “Perfect Storm”

- Demand dropped at hyperscalers with “Return to Work”
- Supply was ramping to keep pace with COVID-driven demand
  - Fortunately, there were few players, so capacity was added with some discipline
- Supply chain issues during the pandemic led customers to build inventories, which are still being burned off
- Result: Historic overcapacity

# Recovery: When???

- Revenue growth soon:
  - Prices have collapsed to cost
  - Bit growth (>20%) \* Cost decline (<15%) = Revenue growth
  - We're there now
  - It's not profitable, but it's growth!
- Profits return much later!
  - Oversupply ends, prices stabilize while costs continue to decline
    - Increasing layer counts driving continuing cost reductions
  - Hard to call. Most producers hope for mid-2024

# NAND is Solid

- Increased layer counts still make sense
- Costs will continue to decline
- Profitability will return
- NOR is another story
  - Discrete NOR under attack from MRAM & FRAM
    - Has reached a cost limit
  - Embedded NOR already being replaced

# Flash Can't Scale

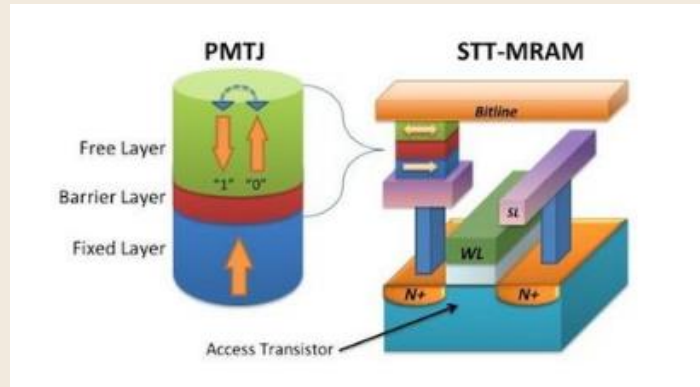
- Discrete NAND had to go 3D after 15nm
  - Now moving to hybrid bonding
- Embedded flash can't shrink past 28nm
  - Foundries are already shipping 3nm logic
- New memory technologies promise to solve this
  - Can scale to sub-10nm nodes

# Lots of Potential Alternatives

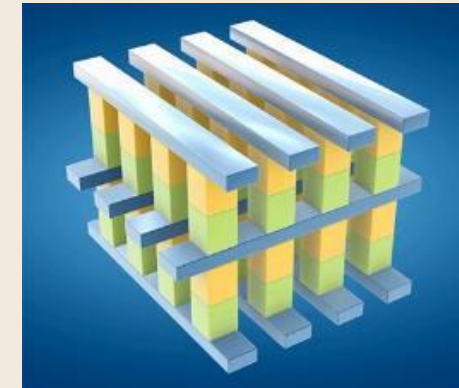


Flash Memory Summit

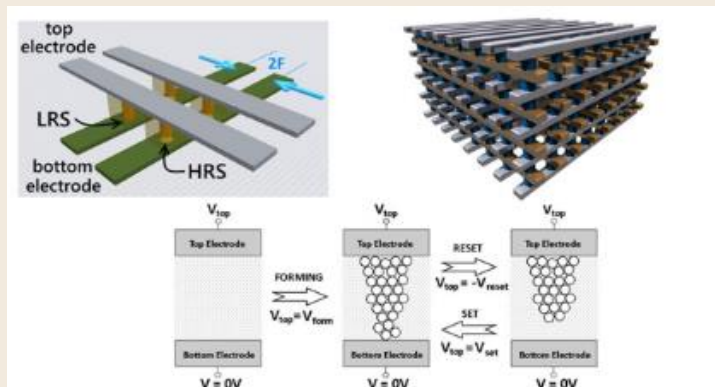
## MRAM



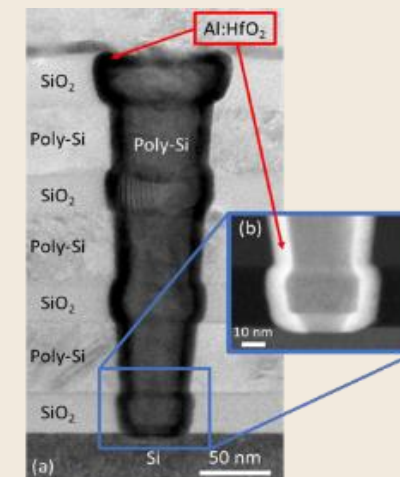
## PCM



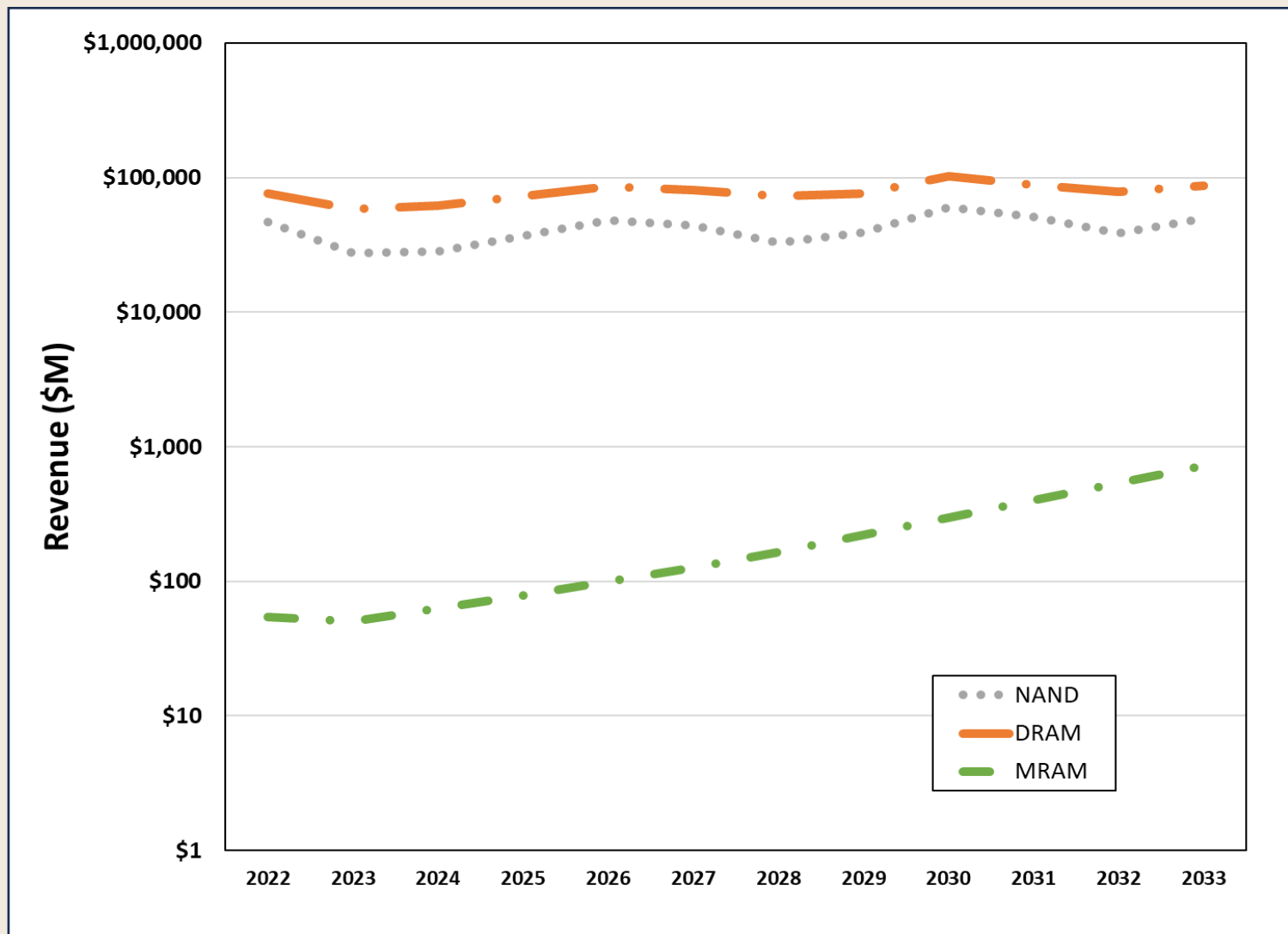
## ReRAM



## FRAM



# The Future of Emerging Memories



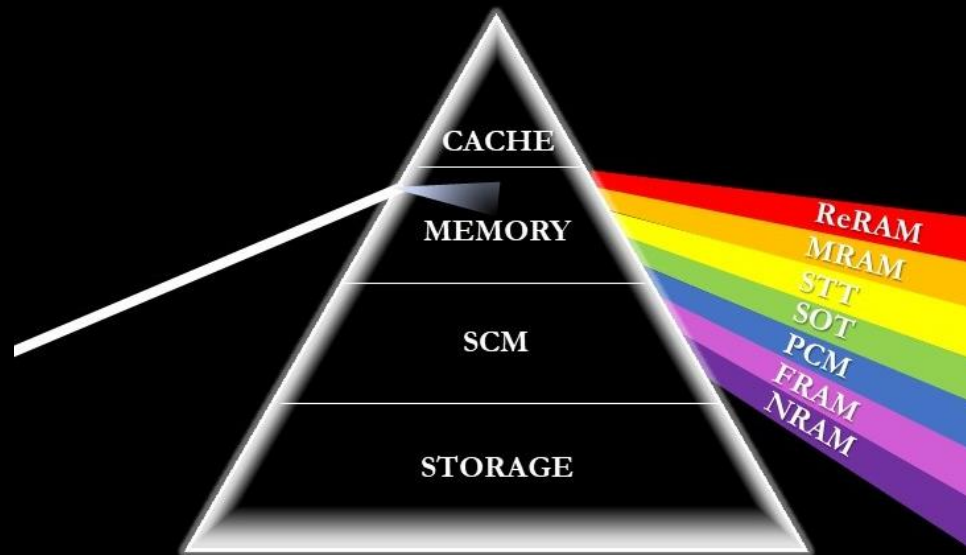
**Stand-alone emerging memory revenue forecast to grow significantly faster than DRAM or NAND flash**





Flash Memory Summit

# New Report: Emerging Memories Branch Out



Coughlin  
Associates  
Data Storage Consulting

Now Available!

<https://Objective-Analysis.com/reports/#Emerging>  
<http://www.tomcoughlin.com/techpapers.htm>