

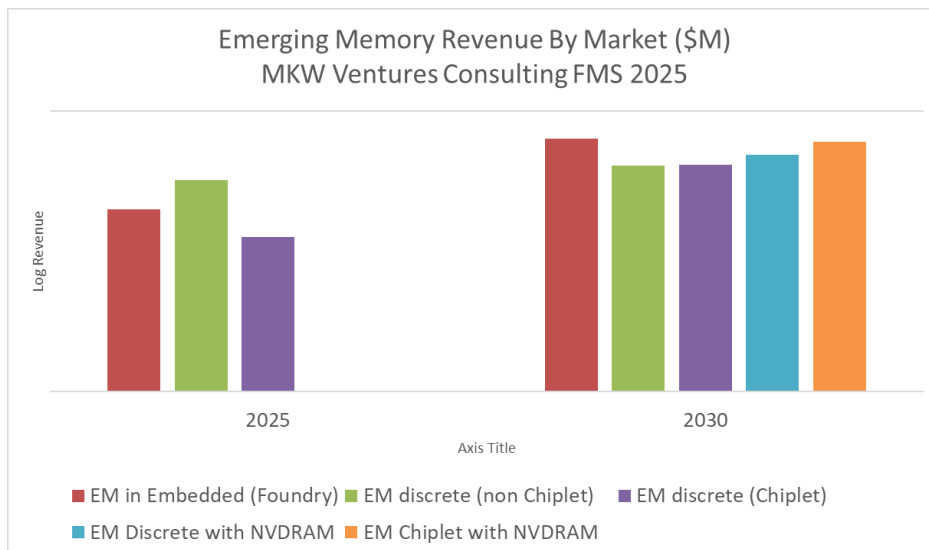
## Future Scenarios for Emerging Memory Markets

OMEM-202-1: Emerging Memory Technologies. Wed 8/6 9:45AM

We show the status today for memories (RRAM, MRAM, PCM, FRAM) and what will happen in the near future. Spoiler alert, There is only ONE new memory that COULD be a major impactor in the next 3-5 years. We show how to monitor progress on all memories.

### Key Takeaways:

- 1) The “Classic” emerging memories RRAM, MRAM, PCM, FE RAM are running and being used in low volume (<\$100M Sales) markets as discrete products. They are also used in embedded foundry technologies replacing eFLASH
- 2) The “New Breakthrough” emerging memories are quite early in their development cycle (we give exact timelines all memories must go through in our product life cycle report). Single cell reports with great latency and  $10^9$  type cycling levels. Until we see a 1Mbit+ array with all performance and bit error rates, These are still 8 years from any possible volume and most likely will not be shipping any units.
- 3) As predicted, the only technology with a possibility sell \$1B worth of units in annually in 5 years must be close to (90% the same steps) of an existing NAND or DRAM process. It must also be within 50% of the cost of the technology.
  - a. This appears to be the plan with FE NVDRAM as reported by Micron in technical papers and more recently by FMC in announcements. All companies are working on this technology
  - b. FE technology, tied to a DRAM process, with tools similar to other high volume tools
  - c. The Key is to see detailed array data and then a real product we can buy ASAP
- 4) A new way to look at this revenue is by submarket, not to lump all emerging memory into one market. We break out these new memory markets



**Summary:** MRAM, RRAM, PCM and small FE arrays emerged a while ago. “New” memories are far from showing the required large array data. FE DRAM has large memory data and the manufacturability needed to become a high volume product