The Storage Demands of the AI Wave: New Opportunities and Challenges for the NAND Industry

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TrendForce

CONTENT

Review and Analysis of NAND Flash Supply-Demand Landscape from 2020 to 2025

Future Trends in NAND Flash Demand amid AI Boom

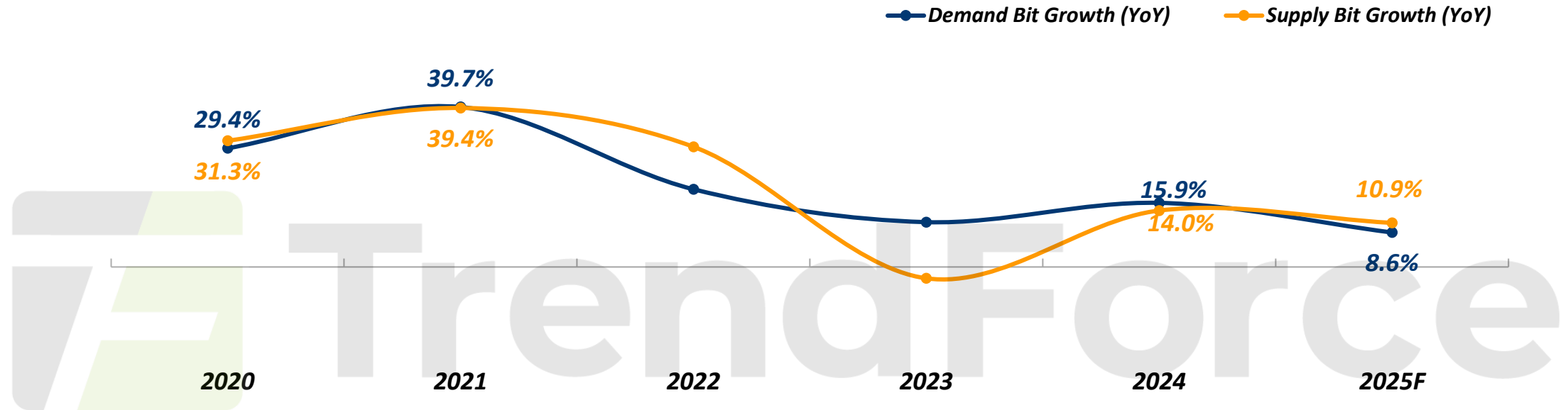Suppliers' Process Advancements and Technologies Strategies to Meet AI Demand

Future Challenges and Potential Opportunities for NAND Flash Industry

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Review and Analysis of NAND Flash Supply-Demand Landscape from 2020 to 2025

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NAND Flash Supply-Demand Dynamics, 2020-2025

YoY Growth Rates of NAND Flash Supply and Demand

— Demand Bit Growth (YoY)   — Supply Bit Growth (YoY)

29.4%
39.7%
39.4%
31.3%
15.9%
14.0%
10.9%
8.6%

2020   2021   2022   2023   2024   2025F

- ☐ **Before 2020:** The average YoY demand growth rate of the NAND Flash market was around 30%.

- ☐ **2021:** Needs related to working from home and distant learning services drove sales of PCs and servers. As a result, the YoY demand growth rate for that year climbed to nearly 40%.

- ☐ **After 2022:** Due to AI-related demand driving the sales of server storage solutions, the YoY demand growth rates ranged between 10% and 15%.

- ☐ **TrendForce forecasts that before significant growth in the demand for NAND Flash solutions used in automotive electronics, the YoY demand growth rate of the whole market will stay around 10-15%.**
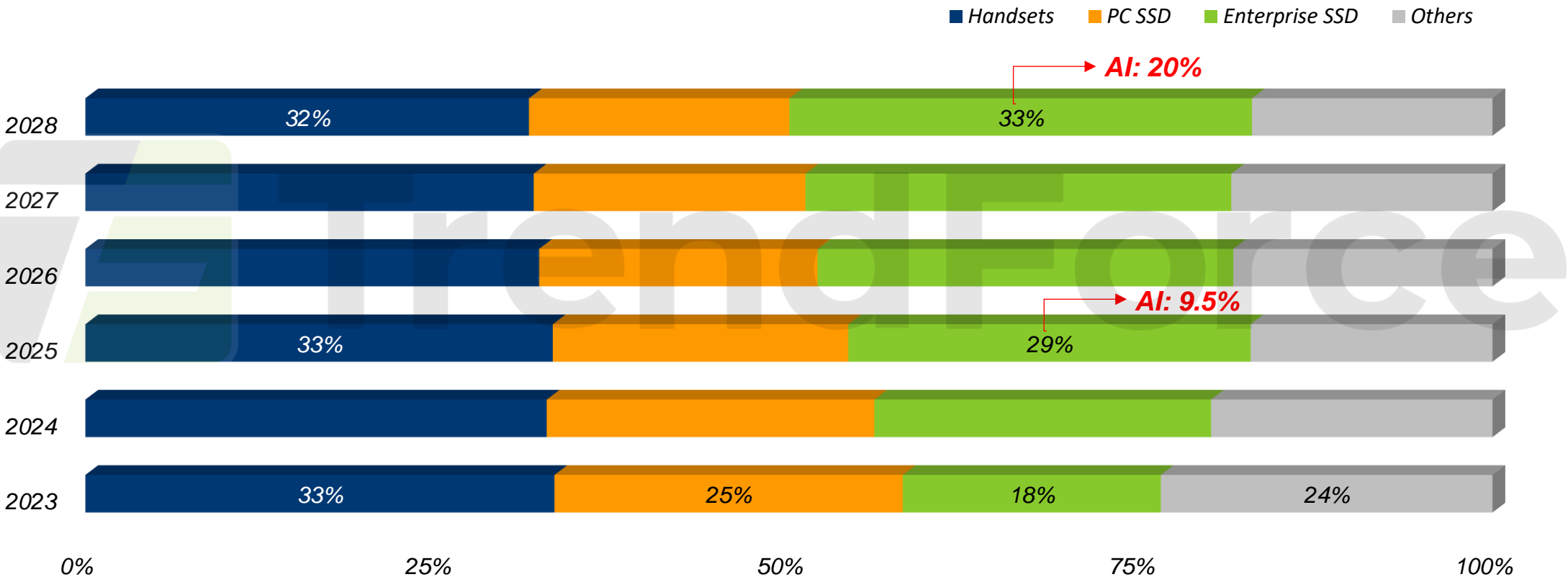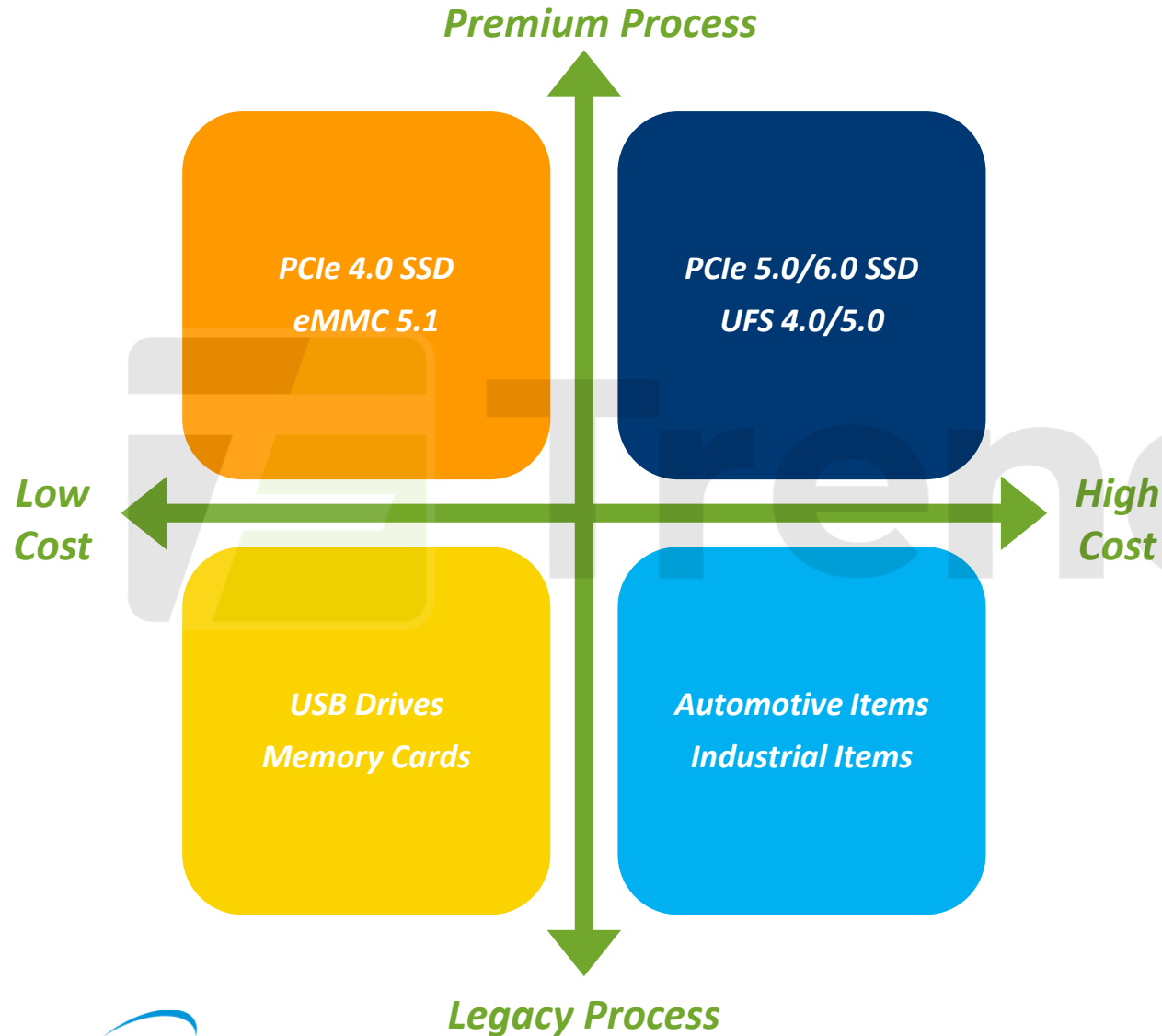
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Future Trends in NAND Flash Demand amid AI Boom

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Future Demand Growth: SSDs for AI Servers Are Expected to Outperform Other Categories of NAND Flash Products

Distribution of NAND Flash Demand by Application

■ Handsets　■ PC SSD　■ Enterprise SSD　■ Others

AI: 20%

AI: 9.5%

Year	Handsets	Enterprise SSD
2028	32%	33%
2027		
2026		
2025	33%	29%
2024		
2023	33% (Handsets), 25% (PC SSD), 18% (Enterprise SSD), 24% (Others)	

0%　25%　50%　75%　100%

Supply Shortages Are Possible for High-End NAND Flash Products in the Future

Premium Process

PCIe 4.0 SSD eMMC 5.1	PCIe 5.0/6.0 SSD UFS 4.0/5.0

Low Cost ← → **High Cost**

USB Drives Memory Cards	Automotive Items Industrial Items

Legacy Process

- ☐ **Demand:** With the rapid development of AI functions in devices, there is an increasing need for high-speed storage solutions to meet zero-latency requirements and support edge AI.

- ☐ **Supply:** Suppliers are focusing more on advanced products such as UFS 5.0 and SSDs featuring PCIe 6.0.

- ☐ **Production Strategy:** To avoid losses, suppliers are gradually transitioning to more advanced process technologies in order to meet the demand for high-end storage products.

- ☐ **Impact:** Delays in suppliers' respective technology migrations may lead to tight supply for products based on advanced processes. This, in turn, may lead to shortages of high-performance storage products.

Future Technological Focus:
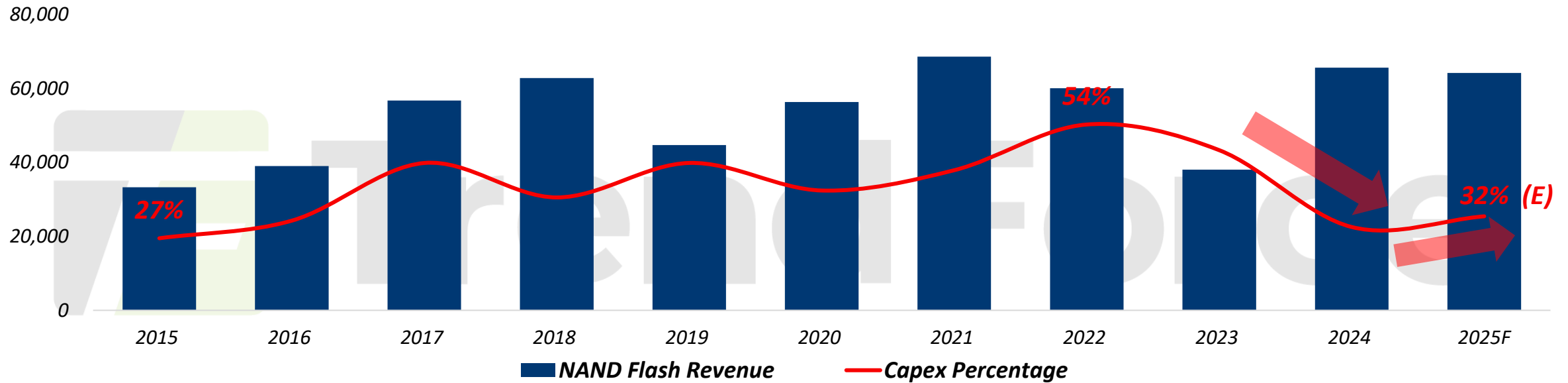# High-Capacity QLC Products and High-Speed NAND Flash Chips

Vendors	2023		2024		2025		2026	
	1H	2H	1H	2H	1H	2H	1H	2H

SAMSUNG
14nm (MLC/TLC)
| V7, 176L (TLC/QLC) | V8, 236L (TLC) ⭐ | V9, 286L (TLC/QLC) |

SK hynix
14nm (MLC/TLC)
| V7,176L(TLC/QLC) ⭐ | V8, 238L (TLC/QLC) | V9, 321L (TLC/QLC) | V10, 375L |

SOLIDIGM
| G5, 192L FG (QLC) | G6, 240L (TLC/QLC) |

KIOXIA SANDISK™
15nm (MLC/TLC)
| ⭐ BiCS5, 112L(TLC/QLC) | BiCS6, 162L (TLC/QLC) | BiCS8, 218L (TLC/QLC) | BiCS9, 2YYL (TLC/QLC) |

micron
16nm (MLC/TLC)
| G8, 232L (TLC/QLC) ⭐ | G9, 276L (TLC/QLC) |

MXIC
19nm (SLC/MLC) ⭐
| 96L (TLC) | 192L (TLC) |

| 2D NAND | 92/96L | 1XX L | 1YY L | 2XX L | 2YY L | 3XX L | 3YY L |

Note: ⭐ indicates the supplier's current primary technology.

Source: TrendForce

Capex as Percentage of Entire NAND Flash Industry's Revenue, 2015-2025

Capex as Percentage of Entire NAND Flash Industry's Revenue, 2015-2025

Unit: Million USD

Legend: NAND Flash Revenue — Capex Percentage

- **2015-2021:** Suppliers actively invested in upgrading processes, with higher-layer products entering mass production every 1.5 to 2 years on average during this period.
- **2022-2024:** To avoid market oversupply, suppliers reduced capex, leading to slow upgrades in process technology.
- **2025:** To meet future demand for AI-related storage products, hybrid bonding now becomes a critical technology, and the industry's capex has returned to positive growth trajectory.

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Future Challenges and Potential Opportunities for NAND Flash Industry

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Challenges – Difficult Balance between Performance Demands and Manufacturing Scale

Performance Challenges
AI-related applications require higher read/write speeds.

Durability Considerations
Frequent reads and writes test the memory's lifespan.

Aligning Capacity with Demand
There are difficulties in adjusting production capacity as demand fluctuates.

Investment Risks
Decisions on capacity expansion face market uncertainties.

Source: TrendForce

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Future Opportunities for NAND Flash Industry

DeepSeek Facilitates AI Deployment

Deployments of servers for AI inference will drive the demand for enterprise SSDs.

QLC Facilitates Storage Capacity Increase among Consumer Products

With the rise of AI, QLC allows consumer electronic devices to adopt larger storage capacity configurations.
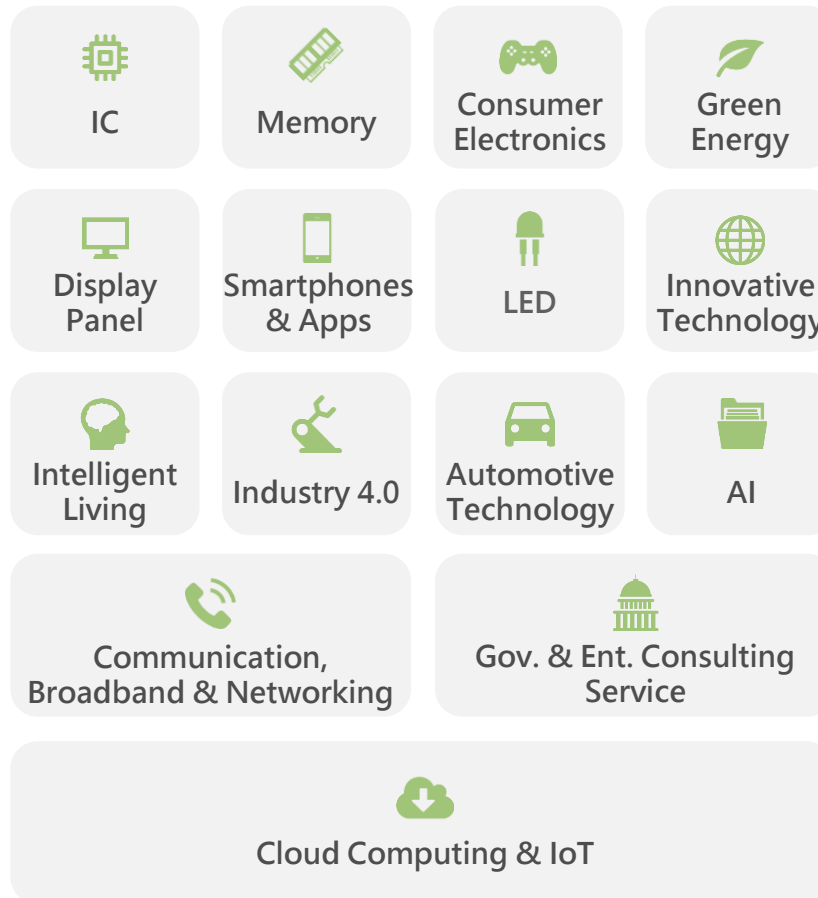
Robotics and Automotive Applications Boost Long-Term Memory Demand

QLC's market share in consumer electronics is expected to continue growing. This cell architecture is expected to eventually become mainstream.

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Source: TrendForce

TrendForce & TRI Research Areas

IC	Memory	Consumer Electronics	Green Energy
Display Panel	Smartphones & Apps	LED	Innovative Technology
Intelligent Living	Industry 4.0	Automotive Technology	AI

Communication, Broadband & Networking

Gov. & Ent. Consulting Service

Cloud Computing & IoT

Sales & Services

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