Capgemini RESEARCH INSTITUTE

The semiconductor industry in the AI era

Innovating for tomorrow's demands

Organizations anticipate surging semiconductor demand

Downstream industries estimate demand for semiconductors to increase at double the rate of the semiconductor industry's expectation

Expected semiconductor demand increase in two years to the end of 2026

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 198 semiconductor industry organizations (includes IDMs, fabless design firms and foundries), N = 800 downstream organizations. Downstream industries are those that rely on semiconductors for their products or services and operations.

Due to Gen AI adoption, nearly three in five semiconductor organizations are seeing increased demand for NPUs, high-performance GPUs, and memory-intensive chips.

Nearly four out of five downstream organizations anticipate increased demand for AI chips, custom silicon chips, and memory-intensive chips over the next 12 months

Expected demand for chips

Proportion of organizations expecting an increase in demand

Average expected increase over the next 12 months

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 800 downstream organizations.

Downstream industries express concerns over semiconductor supply

Fewer than three in ten downstream organizations believe chip supply is sufficient.

Nearly half of downstream organizations are looking for enhanced customization and more comprehensive APIs and SDKs

One in three downstream organizations is designing chips in-house (or currently exploring the option)

Has your organization considered/been considering designing your own semiconductor chips?

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 800 downstream organizations.

Over half of downstream organizations plan to prioritize chip sustainability, supply chain resilience, and cybersecurity features in the next two years.

The semiconductor industry is innovating but softwarization remains a challenge

Focus areas for the semiconductor industry

Design innovation

- Implementation of design-for-test (DFT) and design-for-manufacturability (DFM) techniques
- Development of 3D IC design techniques and multi-die integration
- Exploration of new architectures (e.g., RISC-V, chiplets, heterogeneous integration)

Packaging innovation

- 3D packaging techniques
- Chiplet architecture

Manufacturing innovation

- Manufacturing innovation focused on cost improvement
- Materials research for better yield and/or productivity
- Improving traceability of materials being issued to manufacturing to the source

Hardware security

- Secure firmware and software integration (e.g., firmware updates)
- Cryptographic protection (e.g., hard-ware-based encryption)
- Authentication and access control (e.g., hardware root of trust)

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 210 semiconductor industry organizations for design and manufacturing innovation, N = 192 IDMs, foundries, OSAT firms, capital equipment firms, and EDA firms and 104 IDMs and EDA firms for the bottom statement for packaging innovation N = 161 IDMs, fabless design firms and EDA firms for hardware security.

While nearly half of IDMs and fabless design firms are actively developing software-centric solutions, monetization of software remains a challenge for three in five semi-conductor organizations.

Resilience and sustainability gather momentum

Organizations turn to onshoring and friendshoring to enhance resilience

Semiconductor industry anticipates domestic sourcing to improve by 17% over the next two years

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 202 IDMs, foundries, OSAT firms, capital equipment firms, material and subsystem organizations.

Investment will focus on the US and the EU over the next two years

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 210 semiconductor industry organizations.

The industry is making strides with various sustainability initiatives

Top three initiatives currently being deployed in each category

Energy conservation

- Upgraded to energy-efficient machinery and equipment
- Implemented energy-management systems
- Reduced water usage

Managing hazardous chemicals

- Replaced hazardous chemicals with less toxic alternatives
- Implemented closed-loop systems for chemical reuse
- Recycled or reclaimed chemicals for reuse in processes

Reducing water usage and promoting water circularity

- Implemented water recycling and reuse systems
- Modified processes to reduce water consumption
- Achieved zero waste by reusing all wastewater

Waste reduction

- Implemented waste-minimization programs
- Partnered with organizations on waste-to-resource initiatives
- Designed products and processes to reduce material use
- Utilized end-of-life products as raw materials (closed-loop recycling)

Source: Capgemini Research Institute, Semiconductor survey, November 2024, N = 192 IDMs, foundries, OSAT firms and semiconductor capital equipment firms.

How the semiconductor industry can capitalize on emerging opportunities

Adopt open standards to foster innovation

- Promote industry-wide collaboration for cross-platform interoperability
- Encourage open-source design and development in semiconductor innovation

Protect intellectual property and enhance security measures

- Strengthen cyber defenses and protect data integrity
- Safeguard proprietary technologies

Align with government policies and foster open innovation

- Coordinate strategies with regulatory frameworks
- Collaborate and share innovation

Invest in advanced manufacturing technologies and innovation

- Adopt next-generation fabrication methods
- Accelerate research and development in emerging technologies

Galvanize semiconductor supply chains through diversification and adoption of eco-friendly processes

- Diversify and secure supplier networks
- Implement sustainable manufacturing practices
- Minimize ecological footprint

Harness AI and Gen AI for advanced chip design and manufacturing

- Automate design processes using AI
- Use intelligent systems to improve production efficiency and yields
- Develop AI-optimized semiconductor products

Source: Capgemini Research Institute analysis.

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