Braving the storm: navigating an uncertain future

State of Semiconductors 2025

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PERLab

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Foreword

The fuel source of the digital economy

The semiconductor industry stands at the center of global technological progress today. Demand for chips is surging, driven by cutting-edge AI applications—as well as by the continued need for more established uses in electronics, automotive, and industrial segments.

The top five semiconductor companies—NVIDIA, TSMC, Broadcom, ASML, and Samsung—now collectively command a market capitalization of $5.5 trillion. To get a sense of just how massive and economically important this sector has become, consider that this figure easily outpaces the $3 trillion combined value of the five largest oil and gas companies.

In other words, it's no exaggeration to say that semiconductors have become the fuel of the modern digital economy, enabling and shaping industries worldwide.

While market valuations highlight the semiconductor industry's financial magnitude, a dollar-focused perspective alone cannot capture the unique challenges of semiconductor production and supply management.

Quite unlike oil, though, semiconductors are anything but a commodity. The production of chips demands substantial R&D investment and the meticulous coordination of intricate manufacturing processes, often involving thousands of precise steps.

Today, as demand for semiconductors continues to surge, the global supply network faces unprecedented pressures—not only from supply–demand mismatches, but also from growing geopolitical fragmentation, tariffs, export controls, and shifting trade alliances.

This is an era in which semiconductor capability increasingly defines economic and technological power, and informed decision-making is crucial for staying ahead in this vital sector. The countless complex factors shaping that capability—such as capacity at specific node sizes, equipment lead times, and regional supply dependencies—demand a nuanced and farsighted approach, one that takes into account rapid technological change and increasing geopolitical complexity.

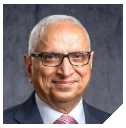
This report is designed to assist leaders in doing exactly that. It delivers a comprehensive and actionable view of the global semiconductor landscape, analyzing supply and demand dynamics across node sizes, chip types, industries, and regions.

It draws on the combined strengths of Kearney PERLab and SEMI to provide a uniquely data-rich perspective. On the demand side, PERLab has conducted die-level teardowns of more than 1,000 electronics products, yielding granular insight into semiconductor consumption patterns across end markets. On the supply side, SEMI—the semiconductor industry's leading association—maintains the World Fab Forecast, the definitive database tracking planned and installed capacity across more than 1,400 established fabrication facilities (fabs) globally.

By integrating PERLab's bottom-up demand analytics with SEMI's unmatched supply visibility, the report surfaces crucial insights on node-specific constraints (both <8nm advanced and >8nm mature nodes), investment trends, and emerging technological shifts. These insights reveal mismatches and inflection points that traditional market views often miss—empowering leaders to better navigate supply chain complexity and mitigate risks of both scarcity and excess.

While this report is written with semiconductor buyers in mind, it also serves as a valuable resource for other players in the semiconductor value chain—including integrated device manufacturers (IDMs), foundry managers, and equipment manufacturers—as well as for policymakers seeking to address the opportunities and challenges arising from this vast and dynamic sector.

Bharat Kapoor
Partner, Kearney



Ajit Manocha
President and CEO, SEMI

Semiconductors have become the fuel of the modern digital economy, enabling and shaping industries worldwide.

Executive summary

Semiconductor capability increasingly defines economic and technological power. The factors shaping that capability—such as capacity at specific node sizes, equipment lead times, and regional supply dependencies—demand a nuanced and farsighted approach, one that takes into account rapid technological change and increasing geopolitical complexity.

Our analysis indicates that annual wafer demand will grow by 4 percent between 2024 and 2027, with fab capacity projected to expand by 8 percent over the same period. However, constraints at the node and component levels could still pose significant challenges to supply chains worldwide.

This will become increasingly true as the demand for artificial intelligence capabilities continues to skyrocket. AI-fueled demand is squeezing cutting-edge capacity, and the effects are filtering into mature nodes serving automotive, industrial, and power management markets.

AI is fundamentally transforming server semiconductor demand. Between 2024 and 2027, AI server volumes are projected to grow at a staggering 40 to 50 percent compound annual growth rate (CAGR)—far outpacing the 8 to 12 percent CAGR for general-purpose servers.

As a result, servers are emerging as the fastest-growing consumer of semiconductors. Between 2024 and 2027, server-related demand is projected to grow at 13 percent annually in our baseline capacity scenario, far ahead of the 2 to 6 percent growth forecasted for all other industries.

AI is reshaping semiconductor demand in the consumer electronics sector, including in the crucially important smartphone and personal computer segments. While we predict that the 40nm–90nm and >350nm segments will likely remain stable, small fluctuations in end-product demand—such as a 3 to 5 percent increase in smartphone sales growth, or a 4 to 6 percent increase in PC sales growth—could strain global chip supply in the <8nm and 90nm–350nm categories.

The rising integration of AI capabilities and the long-anticipated adoption of 5G wireless networks are shifting greater share of demand toward advanced nodes, as devices incorporate more compute-intensive features. As a result, <22nm wafer supply is set to grow at a 14 to 17 percent CAGR through 2027.

The competition for advanced nodes will only intensify. In our survey of global supply chain leaders, more than 40 percent of respondents said they expect to face shortages in <8nm in the near future, while fewer than 15 percent said they foresaw droughts in the >8nm ranges.

With rising international tensions, the semiconductor industry has become a leading target for government intervention. As a result, geopolitics has fully emerged as a crucial determinant of semiconductor supply. The semiconductor industry is confronting a new era shaped by protectionist policies and economic nationalism.

How the industry reacts—by redistributing production, embracing these new policies, or some unforeseen strategy—will determine not only its own future, but the future of virtually every other sector in the modern economy.

Bottlenecks in such crucial areas as lithography equipment, advanced packaging capacity, and skilled fab talent are poised to shape industry dynamics in the coming years. These constraints are becoming as critical as wafer supply itself, potentially shifting the balance of value creation across the supply chain.

In this climate, buyers must turn to product design as a key lever to maximize supply chain resilience. In addition, they must shift from reactive sourcing to dynamic scenario planning, diversify supply sources, secure long-term agreements, and anticipate shifts in competitive dynamics. Firms that design for supply chain resilience, consider competing industries for wafer supply, hedge against geopolitical risk, and proactively secure long-term supply at critical nodes will be best positioned to succeed.

> **How the industry reacts [to this new era] will determine not only its own future, but the future of virtually every other sector in the modern economy.**

From recovery to uncertainty: what lies ahead

The COVID-19 pandemic exposed the vulnerabilities of an increasingly complex and globalized semiconductor supply chain, with disruptions that affected production across sectors, from mobile devices and PCs to electric vehicles and medical equipment.

In more recent years, this network has shown signs of renewed resilience, both for the semiconductor industry and the supply chain upon which it depends. Our analysis indicates that annual wafer demand will grow by 4 percent between 2024 and 2027. Fab capacity is projected to grow at a robust 8 percent over the same period.

Should semiconductor buyers breathe a sigh of relief? Not entirely. Beneath these aggregate numbers lie complexities at the node and component levels that could still pose significant challenges to supply chains worldwide.

Those complexities derive from industry dynamics: AI-fueled demand is squeezing cutting-edge capacity and knock-on effects are filtering into mature nodes serving automotive, industrial, and power management markets.

To explore how all of this might play out in the months and years to come, this report considers three potential scenarios, drawing on different assumptions for demand, GDP growth, and supply capacity. As illustrated in figure 1 on page 6, these conditions combine to generate three broad potential futures: a baseline scenario that is more or less in line with current trends and expectations; a surplus scenario of ample supply and muted demand; and a constrained scenario in which demand markedly outstrips supply.

Under the baseline scenario, fab-utilization levels over the next two or three years are unlikely to reach the levels seen during COVID. In >22nm nodes, we see 7 percent capacity growth between 2024 and 2027, along with a modest 3 percent growth in consumption.

Figure 1

The bifurcation of the global semiconductor supply is becoming more pronounced

	Wafer consumption		**Fabrication capacity**		
Levers	AI, 5G, and EV adoption	Global GDP growth	Under construction fabs	China capacity	Announcements
Baseline	In line with industry estimates	In line with IMF forecasts	On track	Hedged by 50%	Removed
Constrained	Greater than industry estimates	Higher than IMF forecasts	Delayed by two years	Hedged by 50%	Removed
Surplus	Lower than industry estimates	Lower than IMF forecasts	On track	Hedged by 30%	Included

Source: Kearney analysis

In the surplus scenario, double-digit growth in supply far exceeds growth in demand. Both the baseline and surplus scenarios are consistent with our survey data, in line with our finding that more than 60 percent of semiconductor buyers feel confident about procuring chips over the next two to three years.

However, we have also modeled a third, “constrained” scenario, in which AI and electric-vehicle (EV) demand intensifies, while wafer supply is bottlenecked by sanctions on China fabs and a delay in global fab construction. In such a scenario, supply constraints in advanced nodes (<8nm) and certain mature nodes (90nm–350nm) are more than plausible.

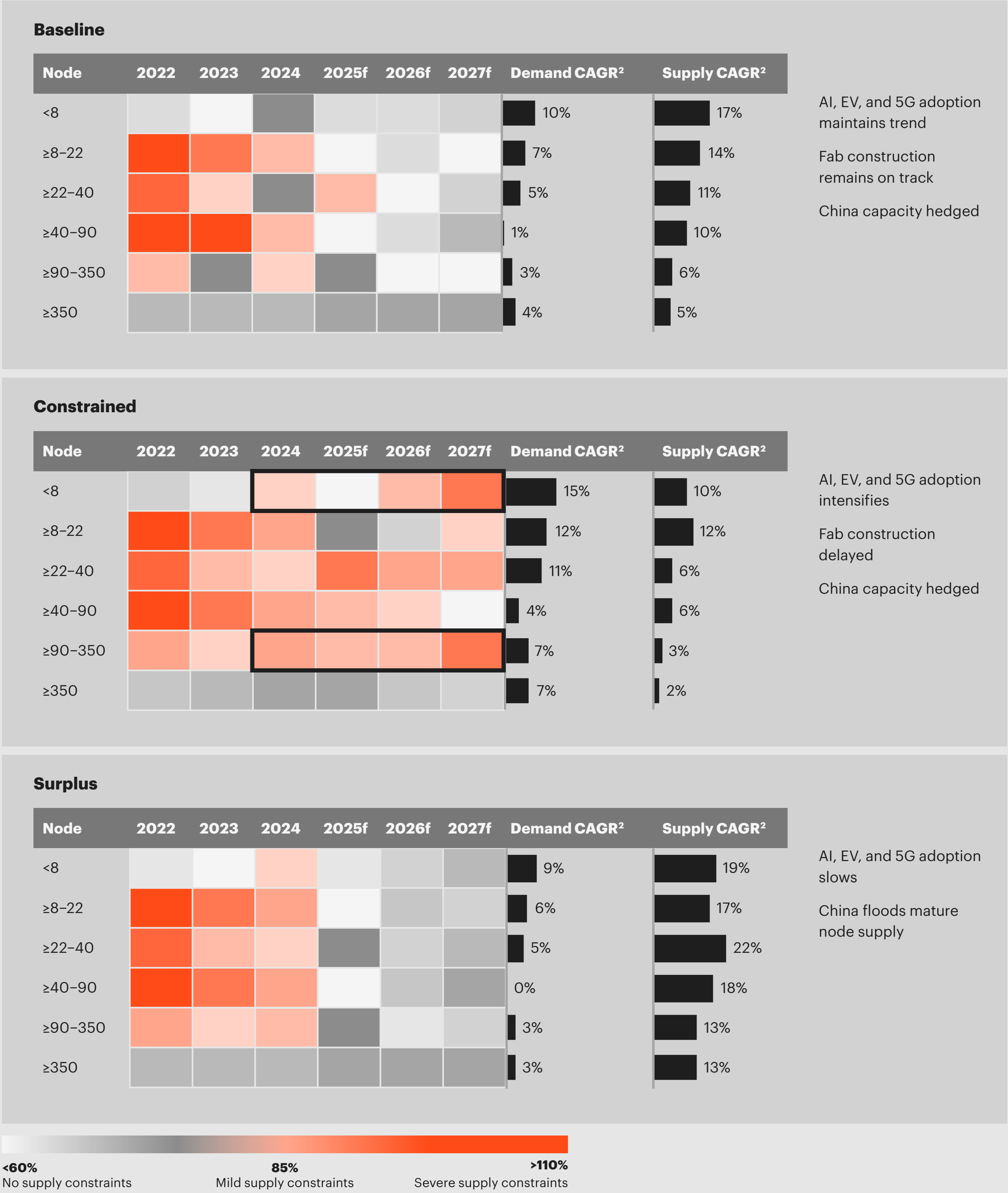
These three scenarios are illustrated in greater detail in figure 2 on page 7.

Figure 2

The extreme shortages of the COVID-19 pandemic are unlikely to repeat, but constraints can develop if AI and EV adoption skyrockets

Capacity risks by node and year

200mm wafer utilization (end product consumption/fab capacity)[1]



[1] Wafer quantities normalized to 200mm wafer equivalents; excludes memory except EEPROM

[2] Demand and supply CAGR are from 2024–2027.

Notes: EV is electric vehicle.

Sources: SEMI World Fab Forecast, industry reports; Kearney analysis

While our analysis indicates that the 40nm–90nm and >350nm segments will remain relatively stable, even in our constrained scenario, just small fluctuations in end-product demand—such as a 3 to 5 percent increase in smartphone sales growth, or a 4 to 6 percent increase in PC sales growth—could strain global chip supply in the <8nm and 90nm–350nm categories.

The risk of this scenario is very real, due to two major forces: AI's insatiable demand for computing power, driving consumption of <8nm advanced nodes; and the growing energy demands of AI and EVs driving up the need for mature-node power management integrated circuits (PMICs). To further complicate matters, several foundries have struggled to add capacity in the <8nm category, and in some cases, have chosen to delay expansions.

The rising integration of AI capabilities and the long-anticipated adoption of 5G wireless networks are shifting greater share of demand toward advanced nodes, as devices incorporate more compute-intensive features. As a result, <22nm wafer supply is set to grow at a 14 to 17 percent compound annual growth rate (CAGR) through 2027, made possible in part by extreme ultraviolet lithography (EUV) scaling and advanced packaging (see figure 3).

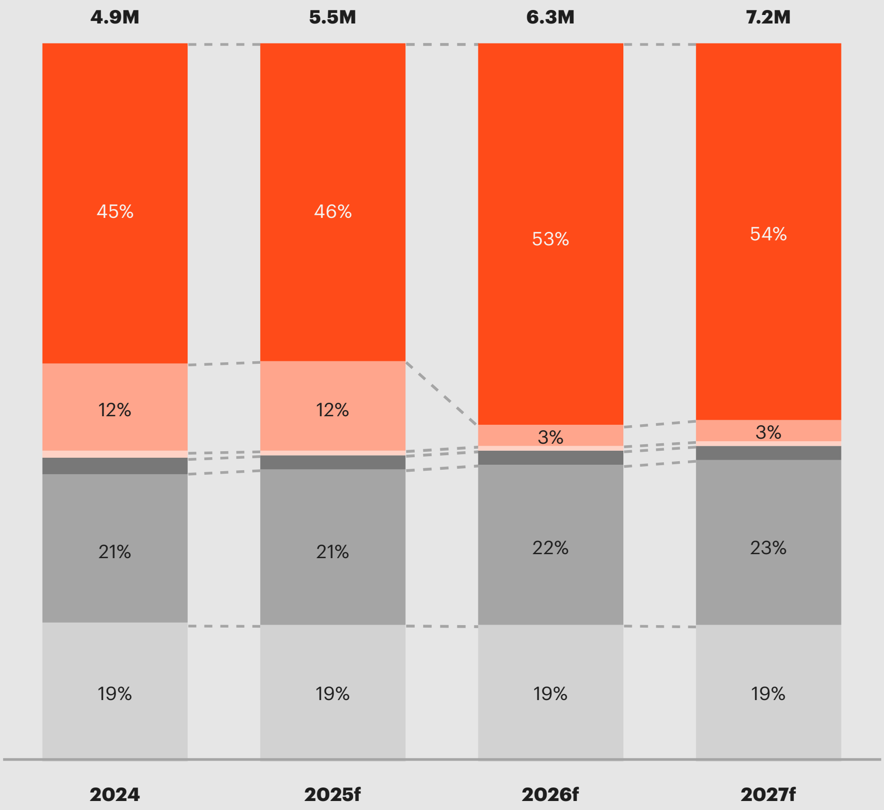
But this growth in advanced-node demand only exacerbates the industry's dependence on a handful of players. Taiwan and the Americas dominate <22nm capacity, while mature nodes remain dispersed across China, Japan, and Europe. If anything, this bifurcation of global semiconductor supply is becoming more pronounced, with mature-node production continuing to fragment (see figure 4 on page 9).

This geographic fragmentation has contributed to a sense of growing unease about future supply. In our survey of more than 200 global supply chain leaders, 42 percent expect shortages at advanced (<8nm) nodes.

This anxiety extends to mature geometries—30 percent of respondents said they anticipate shortfalls in the 8nm–22nm range, while roughly a quarter anticipate tightness at larger chip sizes.

Figure 3
The share of <8nm nodes in servers is slated to increase significantly in the next three years

End-product wafer consumption for the server industry by node
Share of million 200mm wafers[1]

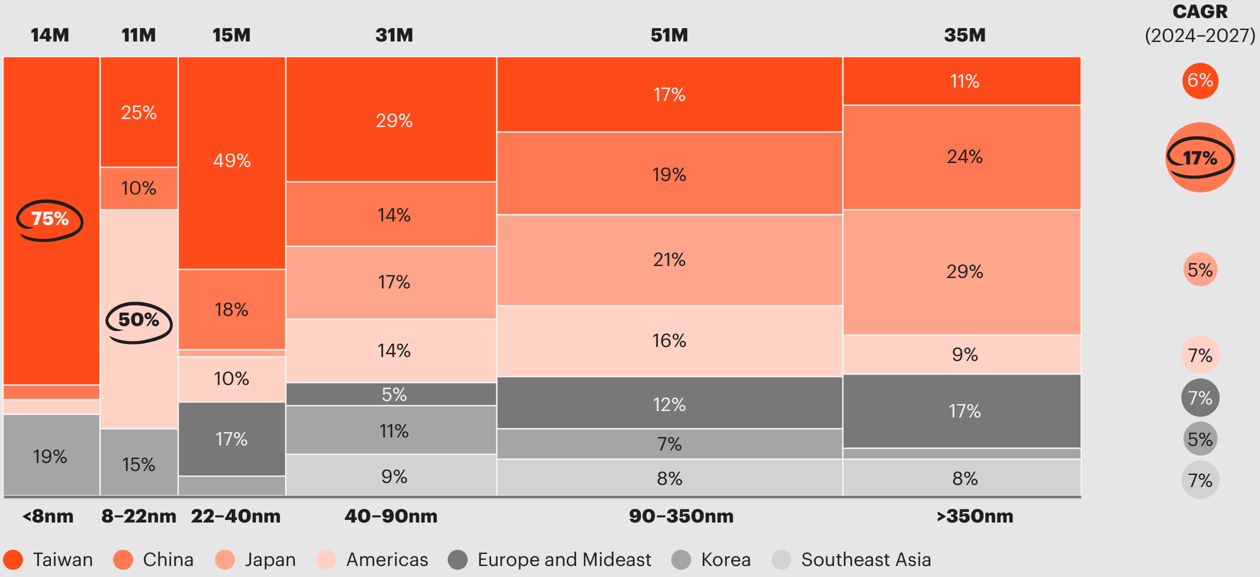


[1] Excludes memory except EEPROM
Source: Kearney analysis

Figure 4

Taiwan and the Americas are leading in <22nm capacity, with mature node capacity fragmented across Taiwan, China, Japan, and the Americas

Fab capacity by node size and region, 2024 (share of million 200mm wafer supply[1])



[1] Excludes memory except EEPROM

Sources: SEMI World Fab Forecast; Kearney analysis

In addition, confidence in procurement strategies has slipped. Only 65 percent of those surveyed now rate themselves “fairly” or “completely” confident in their ability to secure their chip supplies—down sharply from 82 percent last year.

Even so, cautious optimism is building for 2026: 52 percent expect sourcing conditions to improve “slightly”; another 19 percent anticipate that they will improve “significantly.” Such sentiments suggest early payoffs from regional manufacturing bets and strategic inventories, contrasting sharply with pandemic-era pessimism (see figure 5 on page 10).

However, this optimism could prove fragile if AI, EVs, and other advanced technologies cause demand to spike more steeply or precipitously than anticipated, or if geopolitical factors further disrupt supply chains. All of this reinforces the need for continued strategic planning, rather than a reliance on previous assumptions.

To inform that planning, this report looks at semiconductor supply chains from a variety of angles. It opens with a look at how the explosive growth of artificial intelligence is transforming semiconductor demand, with particularly significant consequences for servers. We then look at the evolving components of the semiconductor supply chain and their impacts on capacity, focusing on chiplets, packaging, and wide-bandgap (WBG) technologies.

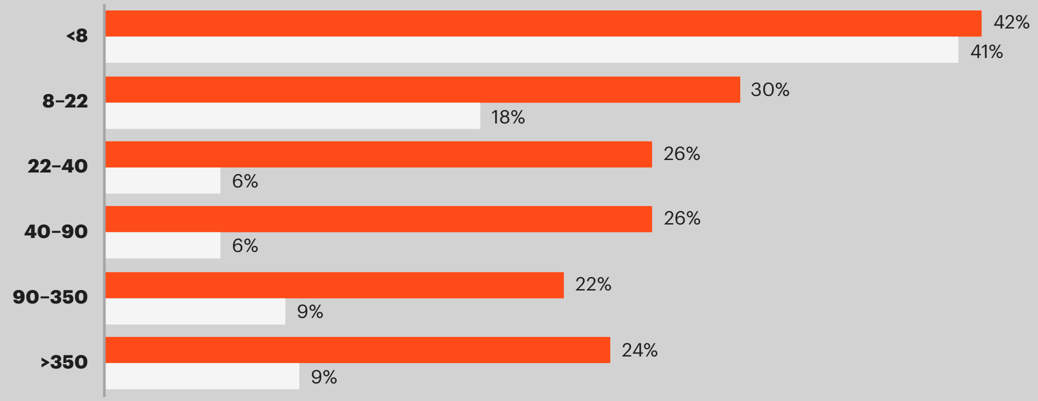
The report proceeds with a review of a half-dozen core economic sectors—from smartphones to EVs—before offering an assessment of the increasingly fraught geopolitical factors that threaten to disrupt the semiconductor industry worldwide. We conclude with a list of actions and approaches that leaders can take to navigate the waters in this increasingly important—and increasingly uncertain—sector.

Figure 5

Semiconductor supply chain confidence is slipping as shortage fears rise, fueled by broader industry uncertainty

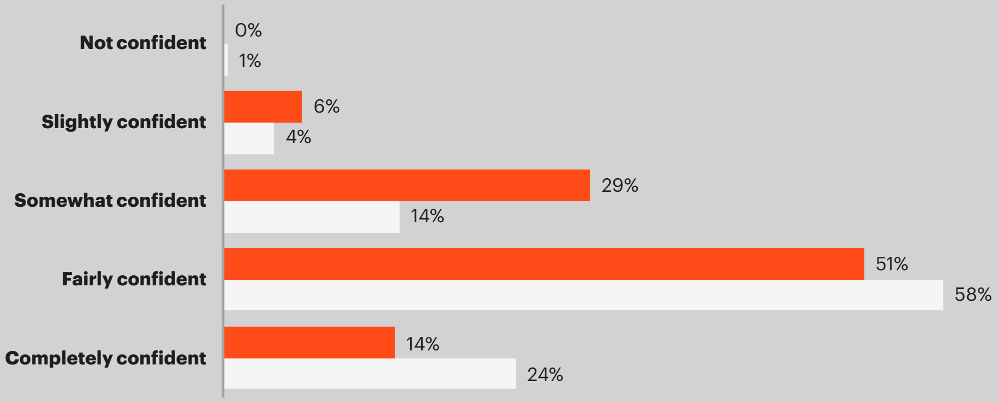
Deeper shortages loom for 2025 across every node

Expected semi shortages by node size



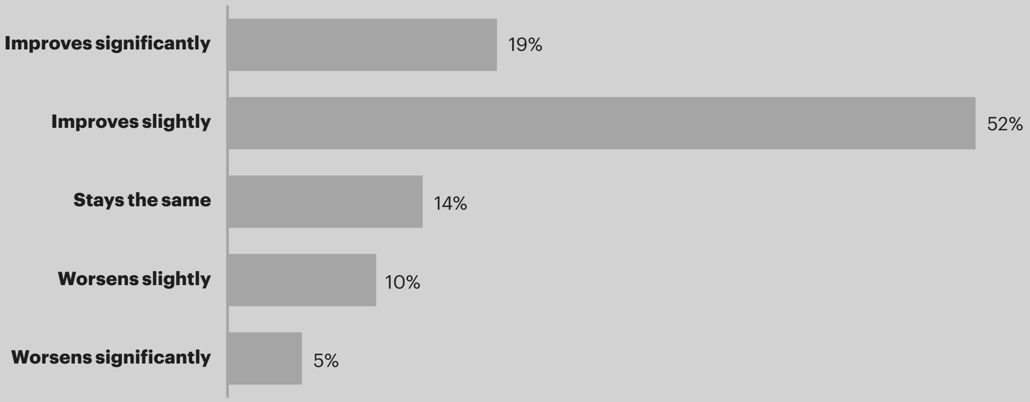
Procurement confidence is slipping as uncertainty rises

Confidence levels in semi procurement strategies



Yet most leaders still bet on a rebound by 2026

Semiconductor sourcing outlook for 2026



○ 2024 ● 2025f ● 2026f

Note: Based on a survey of more than 200 supply chain leaders across industries

Source: Kearney analysis

AI pushing server demand

AI is fundamentally transforming server semiconductor demand. Between 2024 and 2027, AI server volumes are projected to grow at a staggering 40 to 50 percent CAGR—far outpacing the 8 to 12 percent CAGR for general-purpose servers.

As a result, servers are emerging as the fastest-growing consumer of semiconductors. Between 2024 and 2027, server-related demand is projected to grow at 13 percent annually in our baseline capacity scenario, far ahead of the 2 to 6 percent growth forecasted for all other industries.

Over the same period, AI servers will rapidly increase their market share, rising from 4 to 10 percent of all servers. This expansion is driven by investments from the countless entities seeking to build their AI infrastructure, from tech start-ups to national governments.

These AI servers require significantly more silicon and power, with die sizes four times larger and power consumption 10 times higher than general-purpose servers. This densification is reshaping the demand profile for advanced nodes and specialized packaging.

This surge in demand has created significant supply constraints, particularly for graphics processing units (GPUs). GPUs take up about a third of the semiconductor die area of an AI server. The increased usage of GPU-heavy AI servers is boosting demand for advanced nodes, as shown in figure 6 on page 12.

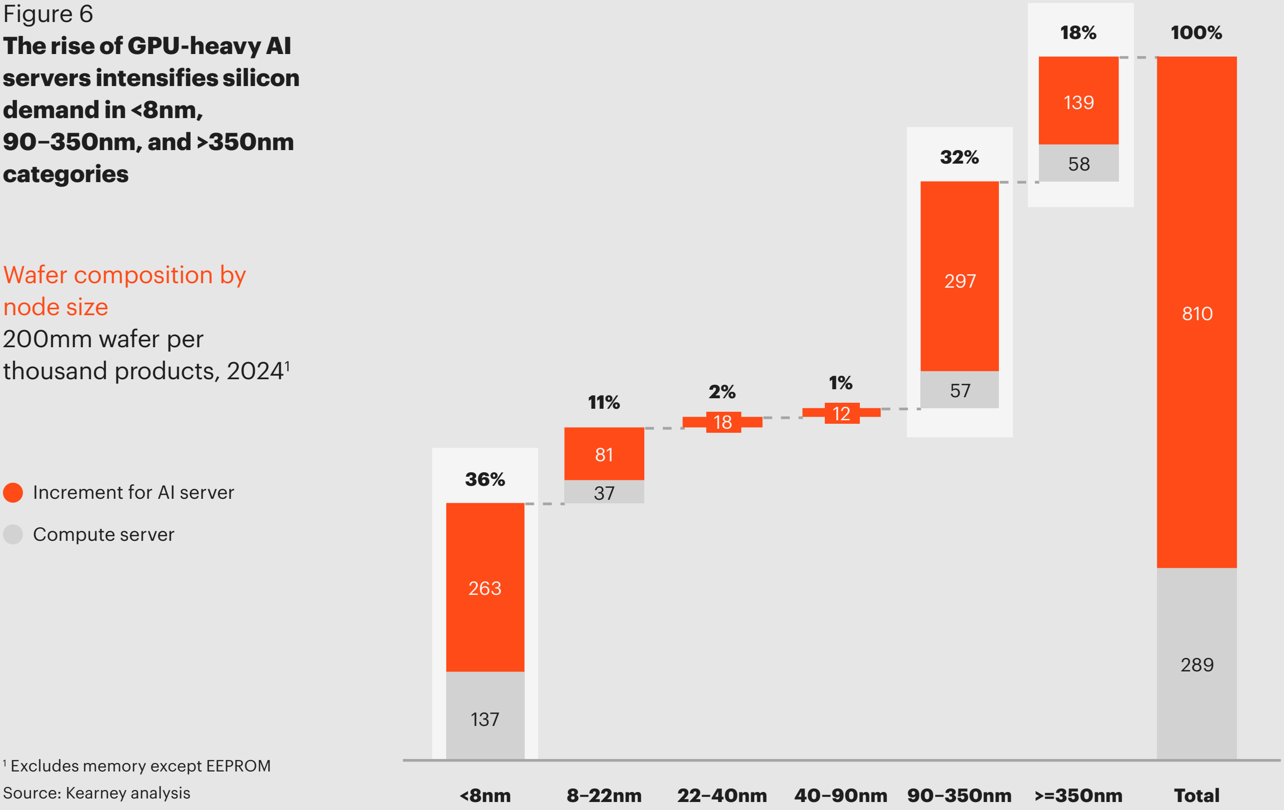
The competition for advanced-node capacity is, to some degree, a story of rivalry between two particularly influential companies, Apple and NVIDIA. Apple, TSMC's largest customer, accounted for 25 percent of the foundry's revenue in 2023, more than double the share of NVIDIA, which took up 10 percent. This dominant position has granted Apple significant bargaining power over TSMC's coveted capacity.

Figure 6

The rise of GPU-heavy AI servers intensifies silicon demand in <8nm, 90–350nm, and >350nm categories

Wafer composition by node size

200mm wafer per thousand products, 2024[1]



[1] Excludes memory except EEPROM

Source: Kearney analysis

However, as demand for AI accelerates, this dynamic may change. A single AI server has roughly the same level of <8nm semiconductor demand as 100 iPhone 15 Pros. As AI-server demand skyrockets, it's not at all hard to imagine a situation in which NVIDIA could rival and even overtake Apple as TSMC's top customer—thereby securing an upper hand in access to wafer supply.

But the growth of AI may not work so tidily in NVIDIA's favor. The addition of on-device AI features on iPhones would increase Apple's semiconductor demand—and might also drive a meaningful uptick in iPhone sales, further strengthening Apple's leverage over TSMC.

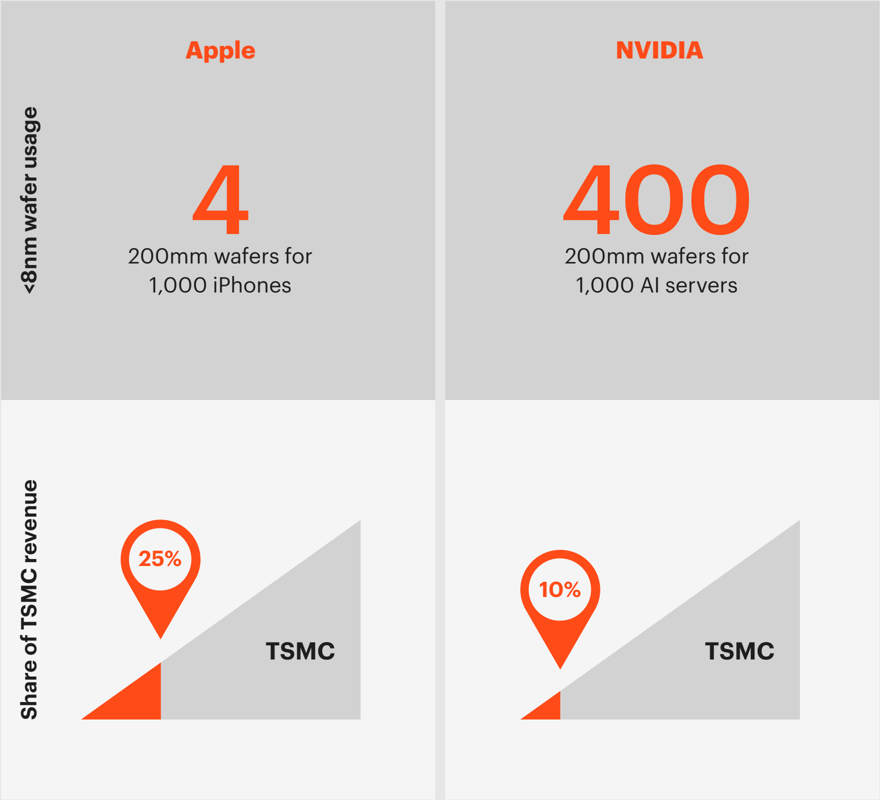
This explains why smartphone demand may govern bargaining power for advanced-node capacity—and why server buyers need to keep a close eye on that demand, adapting their buying strategy accordingly (see figure 7).

There is a broader lesson for server buyers in all of this: the competition for advanced nodes will only intensify. They seem well aware of this already. In our survey of global supply chain leaders, more than 40 percent of respondents said they expect to face shortages in <8nm in the near future, while fewer than 15 percent said they foresaw droughts in the >8nm ranges.

> The increased usage of GPU-heavy AI servers is boosting demand for advanced nodes.

Figure 7
Apple and NVIDIA compete heavily for leading-edge node capacity at TSMC

Competition dynamics between Apple and NVIDIA



[1] Excludes memory except EEPROM
Source: Kearney analysis

Vital—and potentially vulnerable—components of the semiconductor supply chain

Rising AI server demand isn't the only structural factor shaping the semiconductor value chain. Other components are also defining capacity levels. In this section, we briefly look at three of these: chiplets and other lithographic factors; packaging; and wide-bandgap technologies.

Chiplets and lithography

AI's rapid expansion is fundamentally reshaping semiconductor demand across a broad array of technologies. Large-scale AI clusters increasingly depend on high-speed connectivity chips, driving demand for NVLink, PCIe, and next-generation photonic transceivers. These technologies, which typically utilize nodes in the 8nm–40nm range, are intensifying capacity competition across multiple industries.

For server buyers, this divergence in node demand has critical implications. Advanced nodes are vital for maintaining competitive AI infrastructure, but mature nodes will increasingly underpin the scaling of inference applications into broader markets. Developing procurement strategies that account for this duality will be essential to navigating a market where capacity is potentially constrained, and competition is fierce.

In addition, the evolution of AI workloads is transforming chip design priorities. AI inference is poised to surpass training as the dominant workload, spurring the development of specialized inference chips and accelerators. The advent of inference time scaling in reasoning models, such as OpenAI o3 and DeepSeek R1, has further strengthened inference compute demand.

Advanced nodes (≤8nm) will remain indispensable for high-performance inference accelerators, such as NVIDIA's GB200 and Broadcom's custom processors, which are engineered to maximize efficiency and throughput in advanced AI applications.

Yet not all inference tasks require advanced-edge silicon. Power-sensitive and cost-constrained environments—autonomous vehicles, Internet of Things (IoT) devices, and edge AI, for example—employ more mature nodes, typically in the 10nm–22nm range. SEMIFIVE, DeepEdge, and others are already capitalizing on this trend, with 14nm AI processors that balance power efficiency, cost, and performance.

To sum all of this up, changes in semiconductor demand and chip design are demanding a high–low strategy in which companies have to ensure access both to advanced and mature nodes. To navigate these dual pressures, chiplet architectures are emerging as a strategic compromise.

The adoption of chiplet architectures in PCs and smartphones marks a significant shift in consumer electronics design. By breaking processors into smaller, modular components, chiplets enable manufacturers to integrate advanced-node logic with mature-node analog and memory components within a single package, optimizing cost and performance.

This approach improves performance, optimizes power efficiency, and lowers costs by enhancing manufacturing yields at advanced-edge nodes (3nm and 5nm), which are increasingly expensive and difficult to produce at scale.

The modularity of chiplets could also rebalance demand between advanced-edge and mature nodes, easing pressure on foundries and benefiting semiconductor buyers. However, the technology is still in its early stages. In the PC market, AMD's Ryzen processors and Intel's Meteor Lake chips already leverage chiplet designs, combining advanced 4nm cores with 6nm I/O components. Meanwhile, Apple and Qualcomm are reportedly exploring modular architectures to support AI-driven features for smartphones without compromising energy efficiency.

While chiplets help reduce pressure on leading-edge nodes, they shift a significant portion of demand to mature-node manufacturing, making supply–demand forecasting more complex. This redistribution introduces new uncertainties, as mature-node capacity—previously seen as stable—is now subject to greater fluctuations driven by chiplet adoption. As a result, semiconductor buyers and foundries must navigate a more dynamic supply landscape where traditional forecasting models may no longer suffice.

The emergence of chiplets is among the factors that has redefined the role of lithography, the pattern-making process that makes chiplets possible in the first place. A constrained supply of lithographic equipment had formerly been a major source of bottlenecks in the industry, but that supply has stabilized as chipmakers have adjusted their expansion plans. In fact, ASML, the sole provider of extreme ultraviolet (EUV) lithography tools, has lowered its sales forecasts in recent quarters, reflecting softer demand from advanced-edge fabs.

While this alleviates immediate constraints, the long-term outlook suggests a strategic shift in pricing models. As lithography processes become more specialized and difficult to replicate, equipment suppliers may once again demand higher margins. This shift could redistribute value across the semiconductor market, with foundries facing increased costs that may ultimately flow downstream to buyers.

Packaging constraints

While chiplets could ease pressure on leading-edge nodes, their adoption depends on advanced packaging technologies, such as 3D stacking and hybrid bonding, which are already constrained by demand from high-performance computing and AI markets.

With traditional 2D scaling reaching physical and economic limits, advanced packaging is becoming the primary engine of semiconductor innovation—but packaging capacity has not kept pace. This imbalance between demand and available infrastructure suggests that packaging, rather than wafer supply, could emerge as the most significant bottleneck in high-performance computing.

If investment in packaging lags front-end fab expansion, AI accelerators, high-performance computer (HPC) chips, and heterogeneous integration architectures may face prolonged supply constraints.

We have already seen this at TSMC, where the 4nm process line responsible for fabricating NVIDIA's Hopper and Blackwell GPUs has been under immense strain, with the primary capacity constraint being the limited availability of TSMC's advanced CoWoS (chip-on-wafer-on-substrate) packaging technology.

In other words, the primary bottleneck for this crucial technology is no longer wafer fabrication alone, but the packaging process itself. And the consequences of this limitation are substantial. While TSMC is investing more than $5 billion to double CoWoS capacity by the end of 2025, any delay in ramping production could materially slow AI infrastructure deployment.

Looking forward, the supply of CoWoS packaging will determine the trajectory of GPU availability. Server buyers need to monitor any potential delays in expanding CoWoS production, as that would exacerbate supply constraints.

Wide-bandgap technologies (SiC/GaN)

Another consequence of the rise of AI servers is a sharp increase in power usage. AI servers consume up to 10 times more power than general-purpose systems, creating both economic and regulatory incentives for a transition to silicon carbide (SiC) and gallium nitride (GaN) power semiconductors, which are prized for their superior thermal and power efficiency.

These wide-bandgap semiconductors are now the subject of an intensifying competition between the automotive and server industries, with both sectors vying for limited SiC wafer capacity. Advanced manufacturers, such as Wolfspeed, Coherent, and STMicro, are racing to scale SiC production, while GaN efforts are led by Infineon (see figure 8).

Yet wide-bandgap supply is tight, due in part to geopolitical factors. New European power regulations mandating platinum-rated power supply units (PSUs) are set to increase short-term demand for traditional PMICs. Over time, this will likely accelerate the shift toward SiC- and GaN-based solutions, further stoking demand.

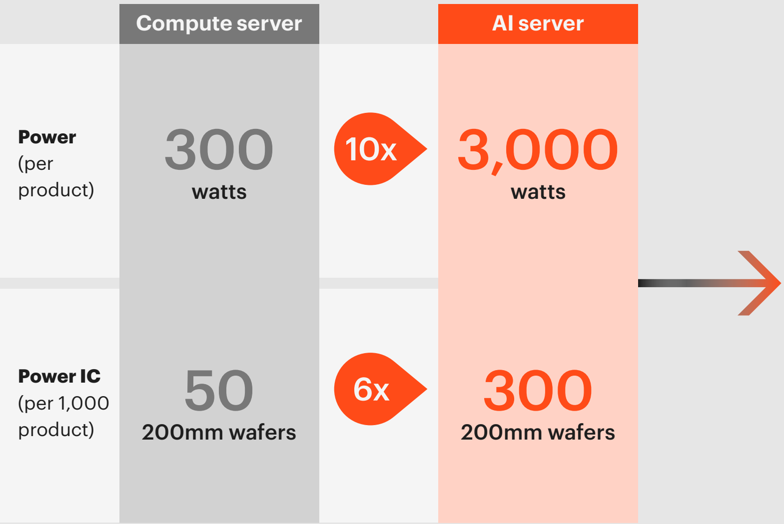
In addition, China's recent ban on gallium exports—critical to GaN production—introduces a significant wrinkle. With more than 95 percent of the world's gallium supply originating in China, these curbs could hinder GaN adoption outside the country and heighten reliance on SiC.

Furthermore, wide-bandgap supply depends to a substantial degree on government funding under the US and EU Chips Acts, while delays in facility construction or equipment procurement could disrupt the supply chain and slow adoption of these advanced materials.

The upshot of all this is that buyers must closely monitor SiC and GaN capacity expansions to safeguard their supply chains and avoid costly disruptions. It seems likely that the abundance or scarcity of these technologies could go a long way toward shaping the long-term availability of power semiconductors.

Figure 8
Exploding power consumption of AI servers has driven substantial investments into SiC and GaN fabs

Power comparison between compute and AI server



	Compute server		AI server
Power (per product)	300 watts	10x	3,000 watts
Power IC (per 1,000 product)	50 200mm wafers	6x	300 200mm wafers

SiC and GaN investments

April 2022: Wolfspeed opens the world's largest 200mm SiC fab (New York).

September 2022: Wolfspeed announces $5 billion SiC wafer plant (Chatham, NC).

March 2023: Infineon acquires GaN Systems for $830 million, doubling down on GaN.

August 2023: Infineon launches €5 billion SiC megafab (Kulim, Malaysia).

May 2024: STMicro commits to a 200mm SiC fab. Production starts in 2026 (Catania, Italy).

October 2024: Wolfspeed shelves its €3 billion German fab due to EV market slowdown.

[1] Excludes memory except EEPROM

Note: SiC is silicon carbide; GaN is gallium nitride; IC is integrated circuit; EV is electric vehicle.

Source: Kearney analysis

Sector review

We now shift to a review of some of the industries whose demand is shaping the semiconductor market. Measuring that demand has historically been a challenge. Current reporting on industry-level demand is beset by multiple limitations that prevent accurate assessments of supply and demand.

For this report, we have sought to overcome these limitations through a combination of secondary research and primary expert interviews. We also triangulated our estimates with the published revenue data of the top companies in each industry.

We further grounded our estimates of semiconductor wafer consumption in an analysis of more than 60 products and more than 5,000 components. This enabled us to better understand the semiconductor composition of specific devices currently in the market. For relatively low-volume products such as washing machines, segmentation into node sizes was based on proprietary databases. For high-volume products such as smartphones, we used X-ray and CT-scan analysis.

We have excluded the server industry from the sector review as that was already covered in the previous sections.

Consumer electronics

The consumer electronics industry is, not surprisingly, the largest and most important consumer of semiconductors. It is neck-and-neck with the automotive segment at node sizes of 350nm or higher, and dominates all smaller nodes, as illustrated in figure 9 on page 18.

Just as consumer electronics dominate within the broader market, smartphones and PCs dominate within the consumer electronics sector. Smartphones alone account for 36 percent of all global semiconductor consumption. PCs account for a further 6 percent.

Obviously, any significant shift in upgrade cycles for smartphones or PCs has the potential to ripple across wafer capacity and availability, affecting the entire market. Our analysis suggests that even a modest 3 to 5 percent uptick in smartphone demand or a 4 to 6 percent increase in PC demand could strain global chip supply, particularly in the <8nm and 90nm–350nm categories (see figure 10 on page 18).

Figure 9

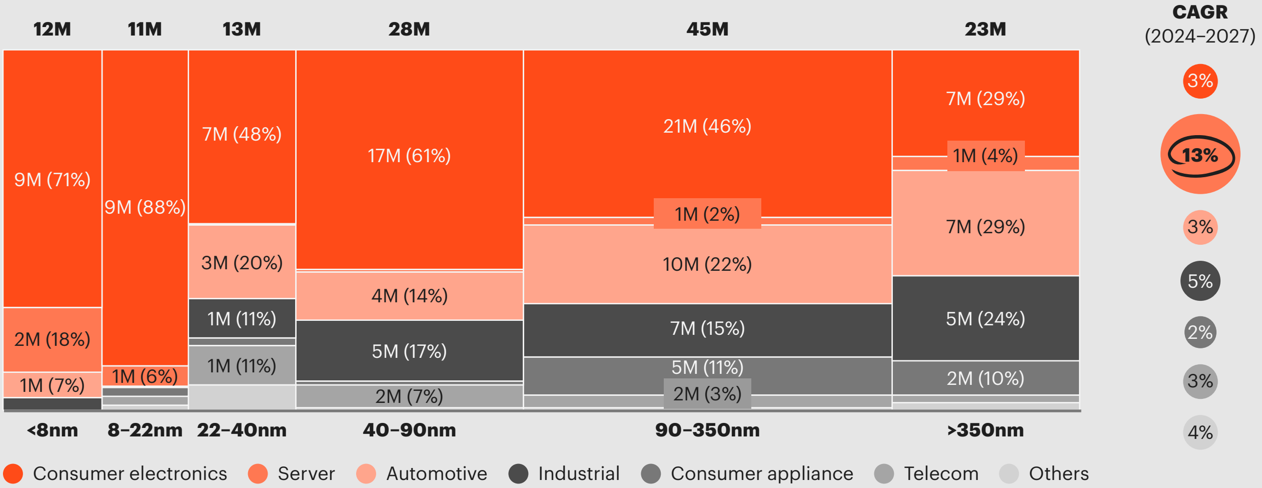
Consumer electronics and automotive drive most consumption, with AI and 5G potentially fueling additional growth

End-product wafer consumption by node size and industry, 2024 (share of million 200mm wafers[1])

AI and compute needs driving the majority of demand growth

5G mobile accounts for >40% of demand, with high-speed digital semiconductors being the largest driver.

Demand is primarily driven by power IC, LADM, and discrete semi across mobile, industrial, and automotive industries.



[1] Excludes memory except EEPROM

Notes: IC is integrated circuit; LADM refers to a broad category of logic/analog/digital/mixed signal ICs.

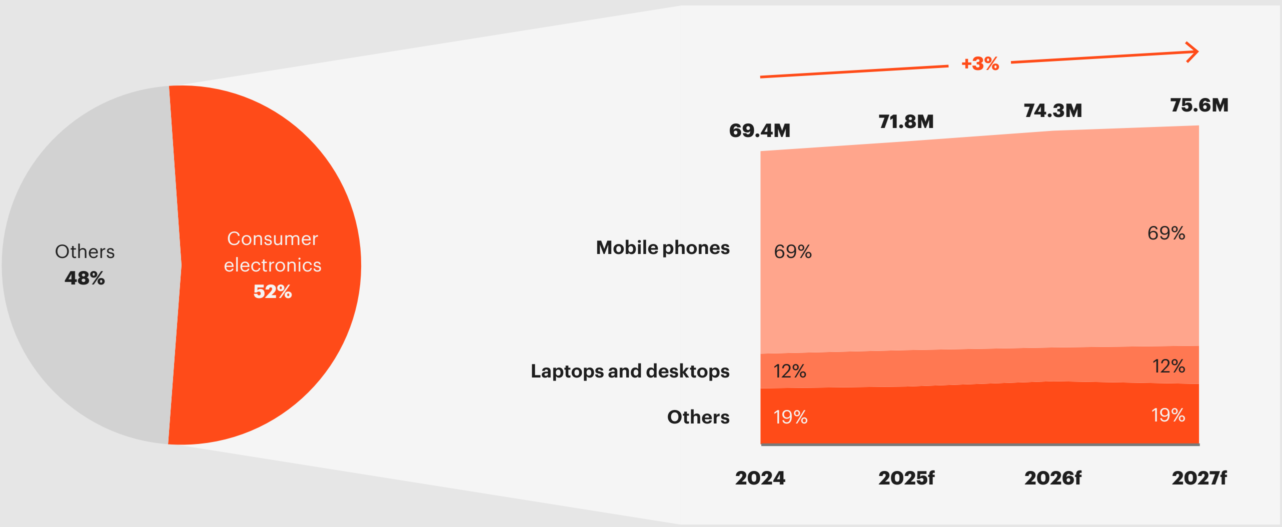
Source: Kearney analysis

Figure 10

More than half of consumer electronics semiconductor demand is for mobile phones and PCs

Global wafer consumption (2024)
Share of million 200mm wafers[1]

Consumer electronics consumption by device type
Share of million 200mm wafers[1]



[1] Excludes memory except EEPROM

Source: Kearney analysis

The rapid integration of on-device AI, within both smartphones and PCs, only intensifies this pressure. The introduction of AI features (such as image generation, text-rewriting tools, and real-time translation) onto these ubiquitous devices heightens demand in two ways—both through increasing per-device chip content, and through sales growth as consumers are attracted to these new offerings.

These functionalities, coupled with the need for greater energy efficiencies, are driving demand for advanced-edge silicon on smartphone and PCs. Processors in recently launched AI-enabled devices, such as Apple's A18 Pro, exemplify this trend.

Our analysis reveals that A18 Pro's die area—built on TSMC's 3nm process—is 2 percent larger than its predecessor, the A17 Pro. At the same time, TSMC is shifting to a 2nm process for the iPhone 17, raising the question of whether there will be further die-size reduction, or a shift toward larger dies to accommodate more advanced features.

For example, the A18 Pro in the iPhone 16, designed for AI workloads, has a 2 percent larger die area than the A17 Pro in the iPhone 15, even though it is built on the same 3nm node size. When viewed in the context of a roughly 13 percent year-over-year growth in iPhone sales, we are now looking at an approximately 15 percent increase in advanced-node demand from iPhones alone.

Yet smartphones remain deeply dependent on mature nodes. Only 10 percent of the semiconductor die area in a flagship 5G smartphone, such as the iPhone 16 Pro, is built on <8nm nodes. By contrast, more than 60 percent of the die area is occupied by components manufactured on 40nm or larger nodes, including PMICs, RF transceivers, and connectivity modules. Similarly, more than 50 percent of PCs' semiconductor composition relies on 40nm+ processes.

This means the semiconductor demand profile for both smartphones and PCs is highly bifurcated. This dual-node dependency creates unique challenges for consumer electronics buyers. In advanced nodes, they face fierce competition from servers, particularly AI workloads, and also from automotive manufacturers as cars and trucks offer ever more sophisticated digital capabilities. Meanwhile, the more mature nodes are contested across a broader spectrum of industries, including the industrial and home-appliance sectors.

For semiconductor buyers in consumer electronics, the critical priority is to monitor the adoption of AI-driven smartphones and PCs, which will influence demand across node categories (see figure 11 on page 20).

Two other consumer electronics categories merit brief mention due to their potential for future growth and their consequent impact on semiconductor demand. One of these is the wearables segment, including smartwatches and fitness trackers. These currently account for a small share of consumer-electronics demand, but this may change as technologies evolve. Some devices, such as the Apple Watch, utilize advanced nodes (5nm), while Garmin's fitness trackers prioritize cost and battery life by relying upon more mature nodes (28nm–65nm).

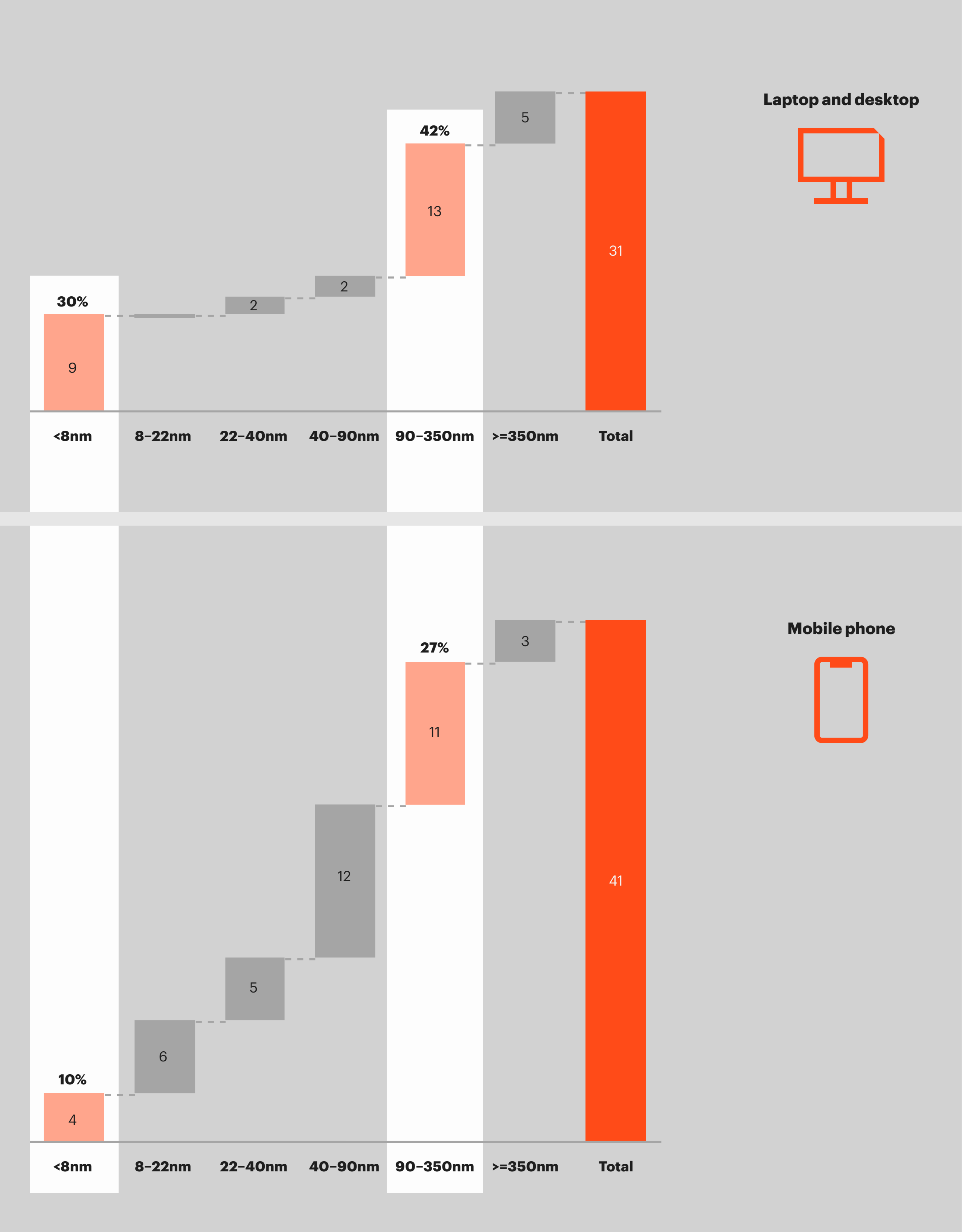
The other emergent consumer electronics category to monitor is augmented reality and virtual reality (AR/VR) devices. These rely primarily on <8nm nodes for graphics processing, with less-intensive power and I/O processing functions delegated to >8nm nodes. Global AR/VR shipments declined 12 percent in 2024, with the much-hyped Apple Vision Pro falling short of projections.

However, by 2028, AR/VR users worldwide are projected to exceed 75 million, with annual headset demand projected to reach over 23 million units by that year—more than a threefold increase from the 7 million units sold in 2024. This level of growth could significantly boost demand for advanced nodes to support AI-driven features, such as motion tracking and immersive rendering.

Figure 11

The key sourcing battlegrounds for PCs and mobile phones are in <8 and 90–350nm

Wafer composition by device (200mm wafer per thousand products, 2024)[1]



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[1] Excludes memory except EEPROM

Source: Kearney analysis

Automotive

The automotive category is obviously a subset of the wider industrial sector, but it merits its own treatment because of its growing importance as a driver (sorry, couldn't resist) of semiconductor demand.

Electric vehicles, in particular, are increasingly blurring the lines between transportation and technology platforms, evolving into "smartphones on wheels." This is motivating a structural shift toward advanced computing and power semiconductors. Features such as discretes and PMICs, commonly used in >90nm node ranges, are particularly prominent in EVs due to the high demands of electrified powertrains and advanced digital systems.

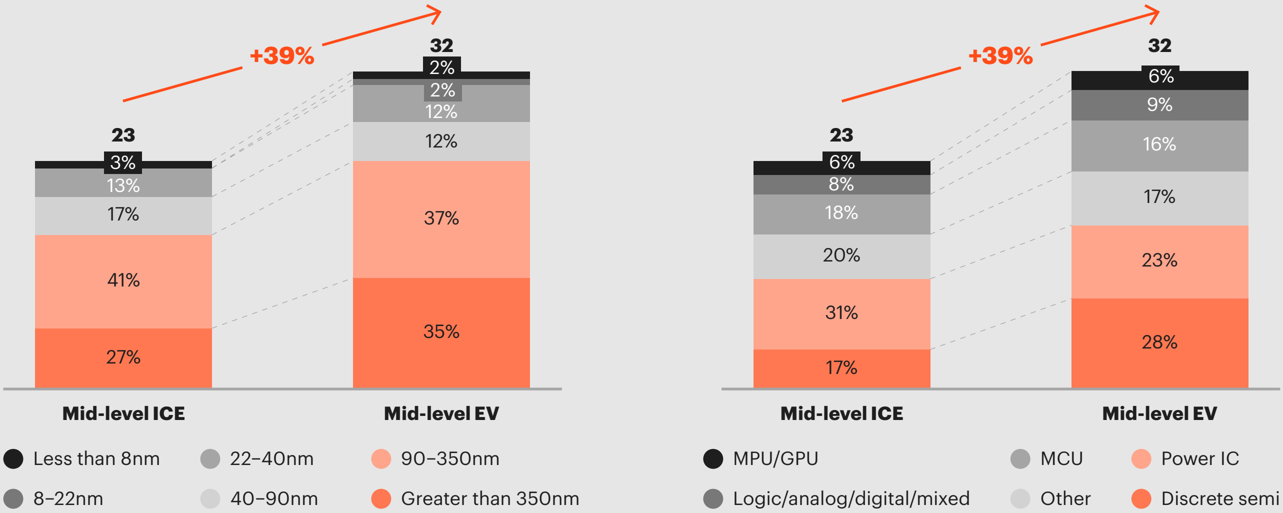
All told, EVs require 39 percent more semiconductor content than traditional internal combustion engine (ICE) vehicles, as shown in figure 12.

The automotive industry's push for advanced driver assistance systems (ADAS) and in-vehicle infotainment (IVI) has significantly increased computational requirements. To that end, automakers are transitioning from distributed ECU-based architectures to centralized, domain-based, or zonal-based architectures powered by advanced application processors.

This shift is driving robust growth in demand for GPUs, microprocessor units (MPUs), and microcontroller units (MCUs) fabricated on 7nm–14nm nodes, which are critical for powering high-performance control and power modules. While the automotive sector currently accounts for only 4 percent of <22nm demand, its share is projected to more than double to 9 percent by 2027, in a segment historically dominated by mobile and server markets.

Figure 12
Mid-level electric vehicles use 40% more semiconductor content than ICE alternatives

Mid-level ICE and EV comparison by node size and commodity type
200mm wafer per thousand products, 2024[1]



[1] Excludes memory except EEPROM

Note: ICE is internal combustion engine; EV is electric vehicle; IC is integrated circuit; MPU is microprocessor unit; GPU is graphics processing unit; MCU is microcontroller unit.

Source: Kearney analysis

This evolution mirrors a transformative shift akin to that of the mobile phone industry in the 2000s, when Apple and others began developing custom silicon for competitive performance gains. A similar divergence is evident in the automotive space, with Tesla leveraging TSMC's N3P (3nm) process for its next-generation Full Self-Driving (FSD) system-on-a-chip, while General Motors plans to adopt Qualcomm's 5nm Snapdragon Ride processors. These approaches highlight the contrasting strategies within the industry: bespoke silicon versus partnerships with established semiconductor platforms.

Much depends on the actual level of consumer demand for EVs, and this is not something that can be predicted with certainty. The EV market has faced, and continues to face, substantial obstacles. Automakers have scaled back EV production targets or postponed major projects in response to slower-than-anticipated market growth following a 2021–2022 market peak. Apple's decision to discontinue its Project Titan autonomous-EV initiative after a decade and nearly $10 billion in investments only underscores the industry's challenges.

While a swift recovery to peak EV demand levels seems unlikely for the moment, unexpected surges in adoption are entirely possible, and could trigger disruptions across supply chains. Demand for high-voltage power components, such as discrete FETs, could potentially crowd out supply for data-center applications. Such a resurgence could also generate shortages in >90nm technologies, which would create ripple effects across multiple industries—including the entire automotive sector.

The rising demand for wide-bandgap semiconductors is another issue where the motor industry looms large, since silicon carbide (SiC) and gallium nitride (GaN) are emerging as critical components in EV designs. SiC has become a staple in EV applications, such as DC/DC converters, onboard chargers, and inverters. Examples include Tesla's SiC metal-oxide semiconductor FETs (MOSFETs) in Model 3 inverters, and General Motors' adoption of Wolfspeed's SiC chips for its Ultium Drive units.

GaN, historically a favorite in consumer electronics for compact chargers, is now expanding into medium-voltage automotive applications, such as battery-management systems, powertrains, and inverters. This expansion is likely to tighten wafer material supplies, with AI-server providers and automotive manufacturers competing for GaN resources. But these are under constraint. China's restrictions on gallium exports limit GaN availability, creating potential bottlenecks in power semiconductor supply for both EVs and AI infrastructure.

Automotive buyers should be prepared for intensified competition for SiC and GaN from the data-center and AI sectors. Securing long-term access to wide-bandgap materials and investing in supplier diversification will be essential in order to mitigate supply risks. As figure 13 on page 23 shows, the auto sector remains at a competitive disadvantage relative to the consumer electronics sector in terms of market leverage in advanced nodes.

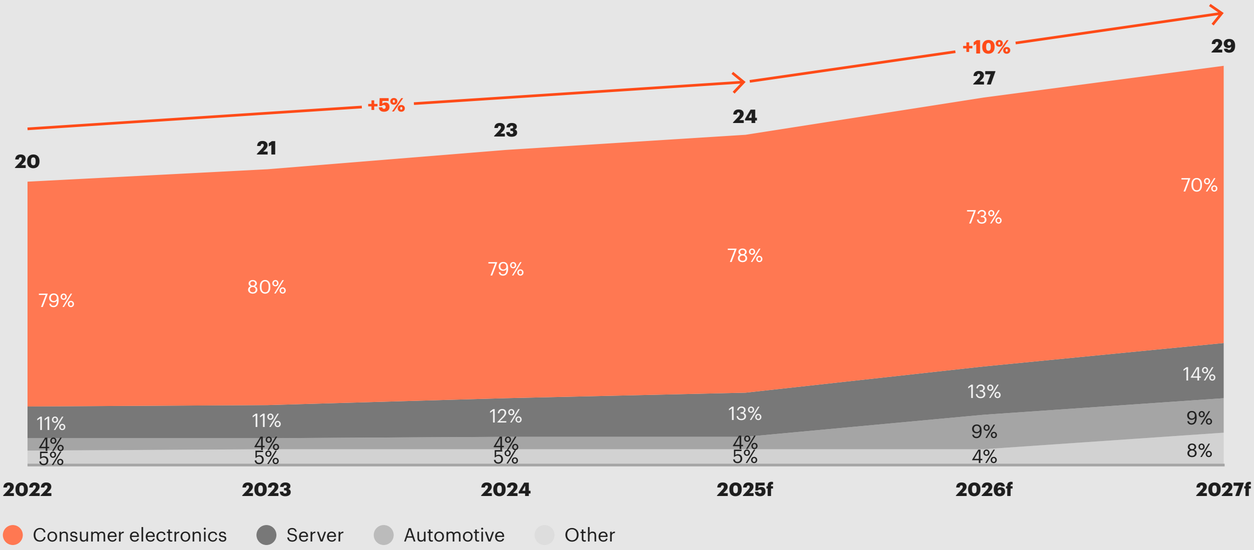
For automotive buyers, this dynamic translates into potential reductions in bargaining power and heightened competition with consumer electronics and industrial sectors for >90nm components. As a result, supply chain resilience remains a crucial focus.

Automotive buyers should be prepared for intensified competition for SiC and GaN from the data-center and AI sectors.

Figure 13

Despite the automotive industry's growing adoption of advanced nodes, consumer electronics still account for the bulk of <22nm demand

Less than 22nm node demand by industry (200mm wafer per thousand products, 2024[1])



[1] Excludes memory except EEPROM

Source: Kearney analysis

Industrial

Even if one breaks out automotive as a separate category, the remainder of the industrial sector is still a major force in the semiconductor market. It's the third-largest consumer of sensor-wafer capacity, after consumer electronics and automobiles.

A significant reason for this prominence is the emergence of what's often referred to as Industry 4.0 or Fourth Industrial Revolution technologies, such as IoT and robotics. These platforms blend the digital and the physical to create smarter, more capable machinery. The result is a surge in semiconductor demand for sensors and connectivity chips, typically manufactured on mature nodes.

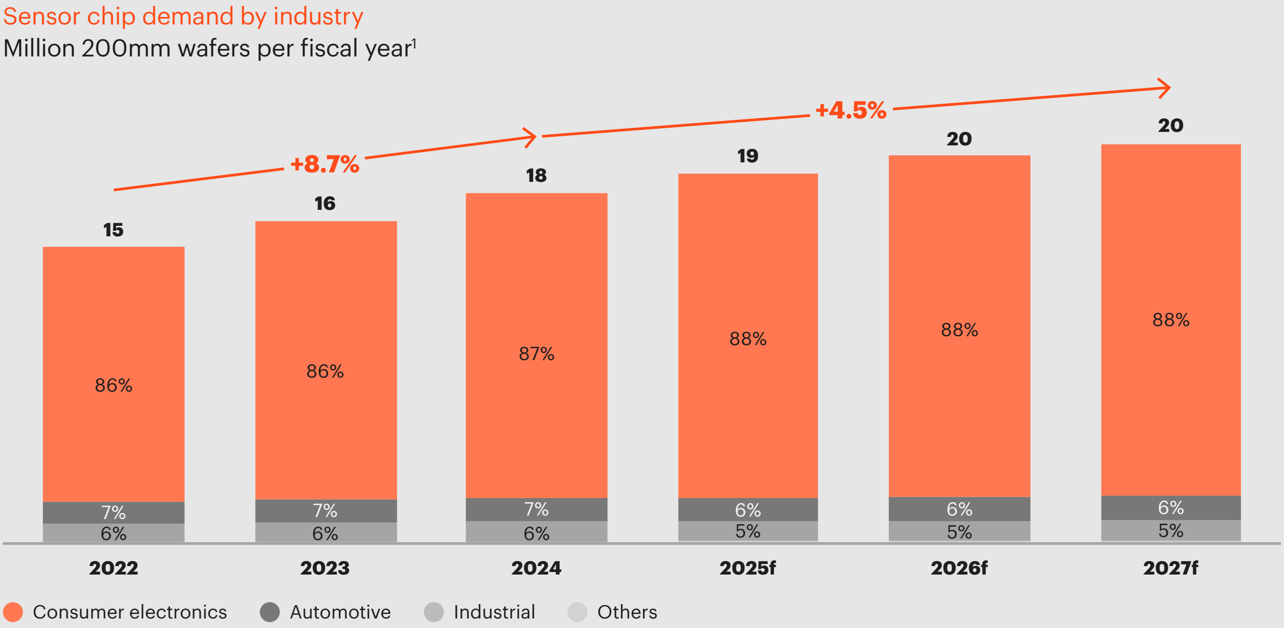
Industrial-sensor demand is projected to grow at a compounded rate of 4.5 percent annually from 2024 to 2027, spurred by the need for real-time data collection for predictive maintenance, industrial automation, and supply chain optimization (see figure 14 on page 24).

This growth is increasing pressure on mature-node capacity, particularly in the 40nm–90nm range—a category already heavily utilized by automotive and consumer electronics buyers. The intensifying competition with automakers for wafer capacity could lead to supply constraints for certain sensor types, especially temperature and magnetic sensors.

While sensor manufacturers ramp up production to meet demand, delays in wafer fabrication could cause bottlenecks. There are already signs that the increasing demand for industrial sensors is putting considerable pressure on sensor suppliers, with many integrated device manufacturers (IDMs) shifting their focus to prioritize the automotive sector's needs.

Figure 14

As sensor chip demand growth slows, consumer electronics are still expected to fuel most of the demand



Sensor chip demand by industry

Million 200mm wafers per fiscal year[1]

[1] Excludes memory except EEPROM

Source: Kearney analysis

The growing demand for machine vision and surveillance systems has driven sustained interest in CMOS image sensors. Despite the technological advancements in more specialized imaging systems, these applications still heavily depend on mature process nodes, especially in the 90nm–350nm range, due to their cost-effectiveness and adequate performance for standard imaging tasks.

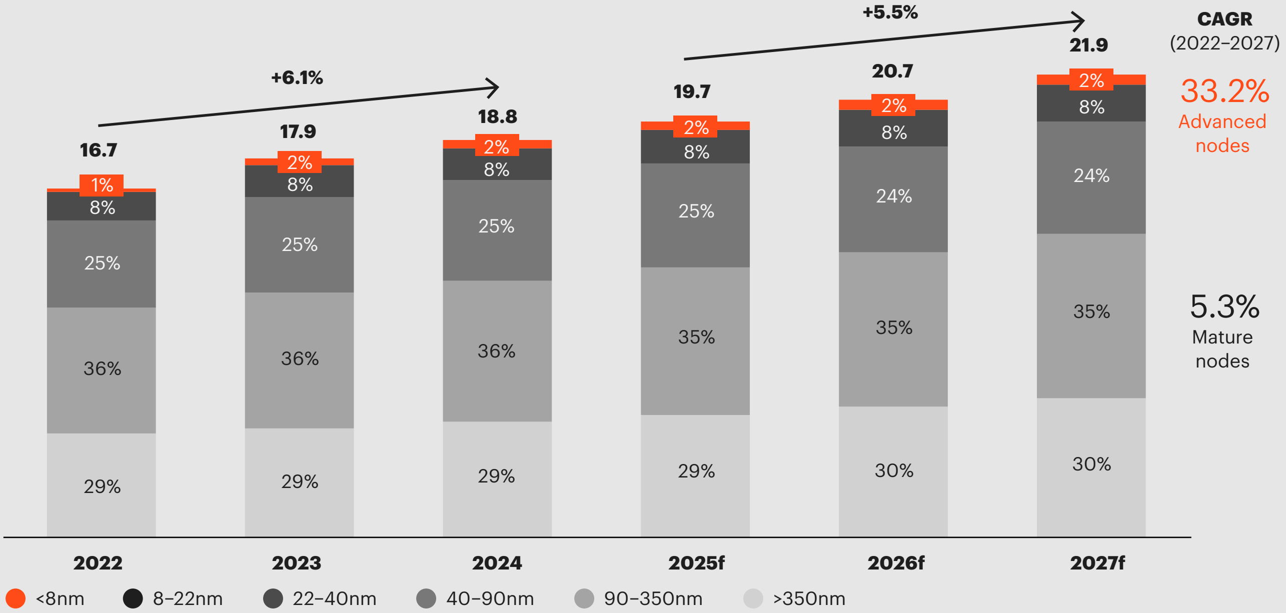
As surveillance and machine vision applications remain cost-sensitive, the focus remains on high-volume production using these mature nodes. At the same time, higher-end applications, including those in autonomous vehicles and advanced robotics, are driving a shift toward more advanced node-based CMOS image-sensing solutions. This transition could further pressure supply chains and create supply competition between industries.

At the same time, the industrial sector is also seeing rising demand for AI-powered edge computing, raising demand levels for more advanced nodes, such as MPUs and systems-on-chip (SoCs) in the 5nm–7nm range. Our analysis indicates that the industrial segment will see a 33 percent compound annual growth rate in the adoption of advanced nodes from 2022 to 2027, primarily driven by the rise of edge-enabled robotics, smart meters, and automated-manufacturing systems (see figure 15 on page 25).

Figure 15

Industrial semiconductor wafer demand is expected to slow slightly compared with the past three years

Industrial demand by node size (million 200mm wafers per fiscal year[1])



[1] Excludes memory except EEPROM

Source: Kearney analysis

Despite this, demand for MPUs and SoCs in edge computing remains relatively small compared to other sectors, such as mobile devices or data centers. Industrial buyers will need to navigate the limited supply of advanced-node semiconductors, where the industrial segment currently represents just 3 percent of wafer demand. This could put industrial buyers at a disadvantage when competing with other sectors for these advanced processing technologies.

For buyers in edge computing, the challenge lies in aligning with advanced-node suppliers that specialize in industrial solutions, in order to secure long-term supply and manage price fluctuations. Buyers should consider consolidating their MPU/SoC platforms across multiple industrial projects to increase their leverage in the advanced-node supply chain.

Home appliances

Even as the smart-appliance market continues to grow steadily, buyers should not find it too challenging to secure chips over the foreseeable term. Smart TVs and connected home devices rely primarily on 12nm–28nm nodes, which have benefited from post-COVID capacity expansions.

The smart TV segment's expansion has been driven by the popularity of video-on-demand services, such as Netflix, Hulu, and Amazon Prime Video. Their emergence has necessitated improvements in Internet speeds and bandwidth.

A growing trend in the smart TV sector is the adoption of touch and display driver integration (TDDI), which consolidates the touch controller and display driver into a single chip. This integration improves performance, reduces power consumption, and enables thinner designs.

While TDDI components are commonly fabricated on 28nm–40nm nodes, cutting-edge applications demanding smaller die sizes or higher power efficiency have increasingly shifted toward more advanced 16nm–22nm nodes.

Most TV SoCs supporting HD/4K features are built on 12nm–28nm nodes, typically incorporating ARM Cortex CPUs to ensure compatibility with various audio and video standards. Streaming devices, aside from Apple's A15 Bionic chip at 5nm, predominantly rely on the same 12nm–28nm nodes, resulting in competitive capacity within this range. Buyers in this category should be prepared for lower buying power relative to major consumer electronics manufacturers, which dominate demand for components in these segments.

This is in contrast with other consumer appliances such as washing machines, which use >40nm chips. The difference is illustrative of the considerable range in chip size needs within this diverse sector (see figure 16 on page 27).

Washing machines are an example of what is still sometimes referred to as the "white goods" segment, which in this usage refers to large home appliances that were commonly painted white; refrigerators, stoves, and dishwashers are other members of this category. (The "white goods" term is also sometimes used as a descriptor of home linens like towels, tablecloths, and bedsheets.)

This class of home appliances is projected to grow at a healthy CAGR of 8 percent, fueled by urbanization and population growth, especially in developing regions. Many appliances, such as refrigerators and air conditioners, operate continuously, creating high demand for low-power PMICs, such as specialized FD-SOI (fully depleted silicon-on-insulator) chips fabricated on 20nm nodes. While supply constraints in the 12nm–28nm range appear manageable, limited suppliers for FD-SOI chips make strategic planning crucial for manufacturers in this space.

New features, such as energy and water efficiency and health-focused enhancements such as antibacterial coatings in air purification remain the primary drivers for upgrades in this sector. The energy-efficient appliance market has surged in popularity, and energy-efficient appliances, such as heat pumps, air conditioners, and smart refrigerators, are gradually adopting SiC and GaN power semiconductors, following trends in EVs and AI servers.

Regulatory mandates on energy efficiency could accelerate wide-bandgap semiconductor adoption, creating potential supply chain challenges for appliance manufacturers as they compete with automotive and server buyers for wide-bandgap capacity.

In the long term, the balance between efficiency and cost-consciousness in the appliance market will shape the adoption of wide-bandgap technologies. Industry leaders, such as Wolfspeed, Infineon, and Qorvo, have introduced SiC and GaN portfolios for heat pumps, air conditioners, smart refrigerators, and other appliances, emphasizing their advantages in power efficiency and thermal performance.

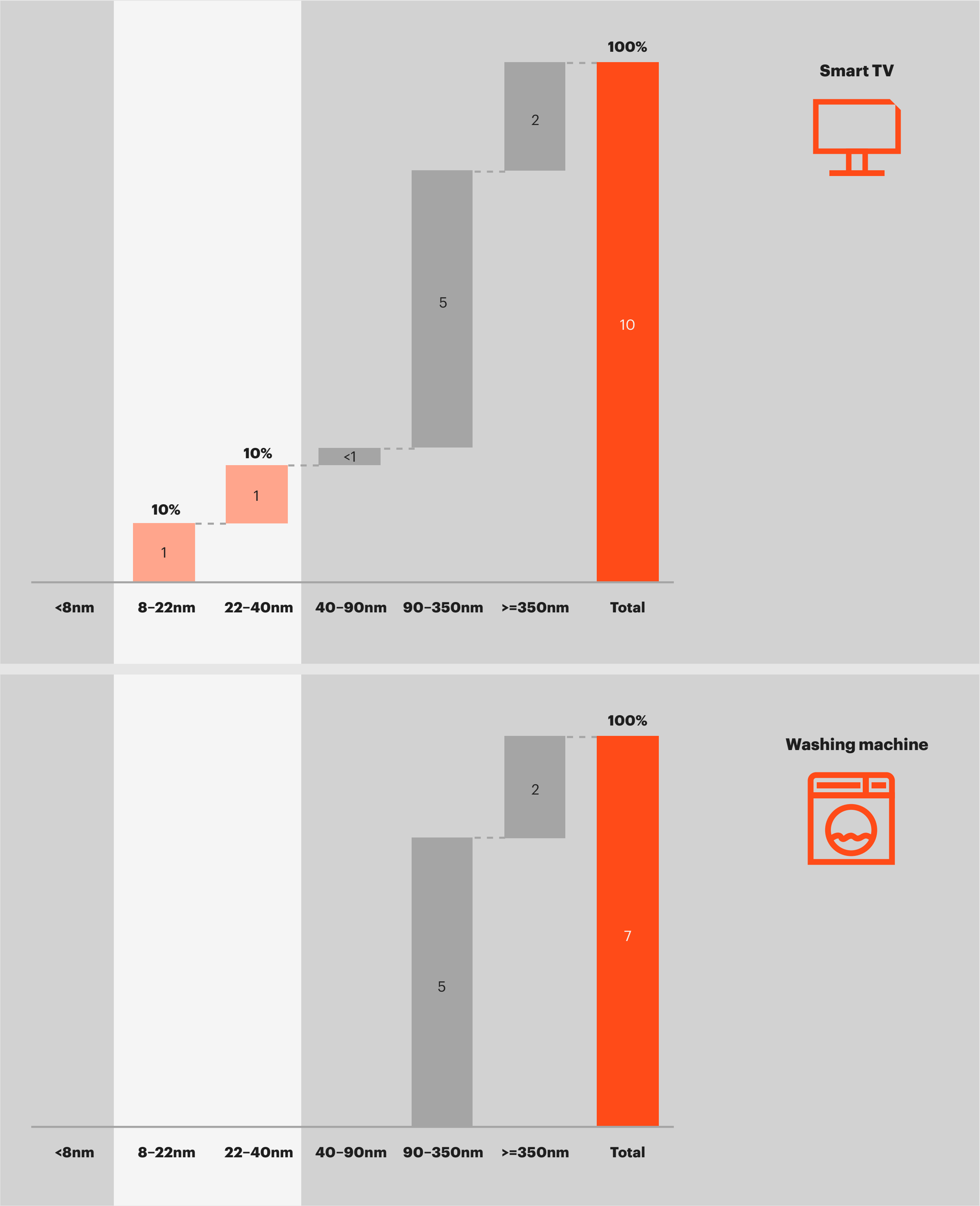
Although demand for SiC and GaN in household appliances remains low compared to automotive or consumer electronics, declining production costs and global regulatory pressure for energy efficiency are set to accelerate adoption in premium and smart appliance categories. Appliance buyers should consider building direct relationships with key wide-bandgap suppliers to ensure stable supply chains.

Figure 16

Relative to traditional consumer appliances, smart TVs include much more <40nm content

Wafer composition by device

200mm wafer per thousand products, 2024



Source: Kearney analysis

Telecom

The widespread adoption of 5G networks, which promise to revolutionize connectivity with higher speeds and lower latency, has unfolded more slowly than anticipated. Telecom operators continue to face challenges identifying use cases that justify the investments required for 5G infrastructure.

The pace of 5G expansion has implications for semiconductor demand, particularly for radio frequency integrated circuits (RFICs), which are typically produced within the 40nm–90nm range, and are crucial for enabling the high-frequency communication required by 5G networks.

The importance of RFICs within the sector is indicated in figure 17. Also worth noting here is telecom's heavy reliance on 28nm–40nm connectivity chips, which are increasingly constrained as mobile and industrial applications compete for supply.

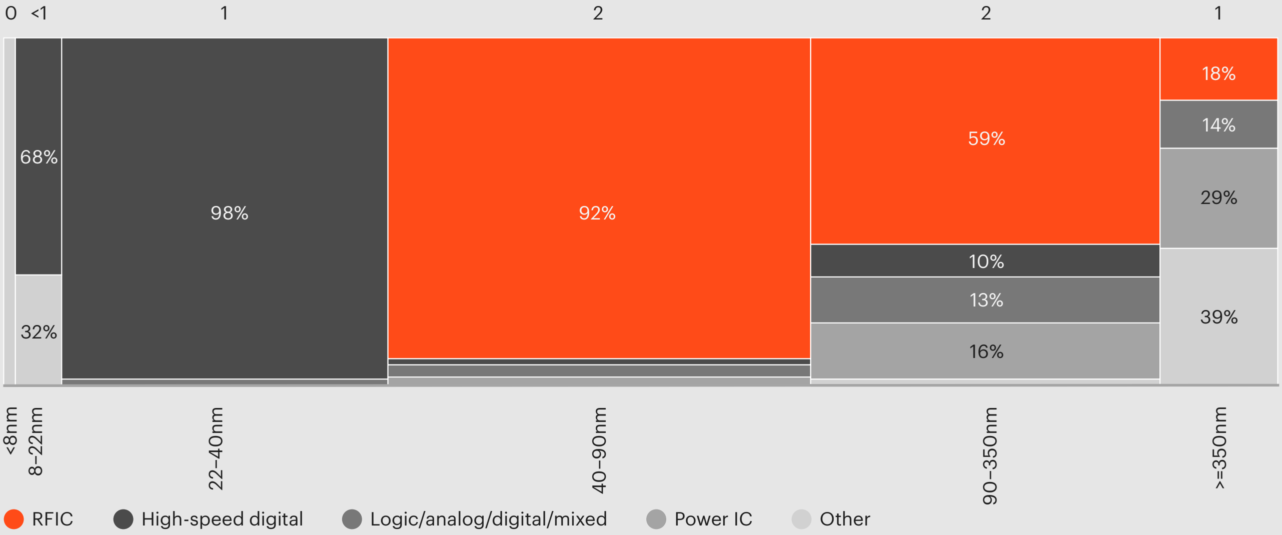
Vertical integration within industries is a major factor in accelerating 5G adoption, as businesses look for tailored solutions to their connectivity needs. As industries vertically integrate and develop 5G solutions, the complexity and specificity of these semiconductors will also increase. Enterprise-specific applications, such as private 5G networks offered by hyperscalers AWS and Microsoft Azure, are gaining traction. In the US, these networks leverage the CBRS spectrum to provide enterprises with secure, scalable connectivity options.

Additionally, the advent of network slicing, exemplified by T-Mobile's beta launch for application-specific slices, is increasing 5G's potential. However, until more concrete enterprise and consumer applications emerge, 5G's adoption will likely remain gradual.

Meanwhile, edge computing and optical networking are reshaping semiconductor needs, with telecom operators investing in SOI-based silicon photonics to support AI-driven, low-latency applications.

Figure 17
RFICs account for almost half of the telecom industry's total demand for semiconductors

Telecom demand by node size and commodity type, 2025
Share of million 200mm wafer demand[1]



[1] Excludes memory except EEPROM
Note: RFICs are radio frequency integrated circuits.
Source: Kearney analysis

The rise of edge computing is closely tied to the accelerated implementation of 5G, driven by its applications in autonomous vehicles, healthcare, and retail. By leveraging Open RAN, virtualized RAN, and multi-access edge computing, telecom operators are improving network efficiency and reducing latency. To meet the demands of edge computing, telecom-specific SoCs optimized for connectivity are typically manufactured at 20nm–40nm nodes, balancing cost, performance, and power efficiency.

Optical-networking advancements are further reshaping the telecom landscape. With the increasing demand for high-speed Internet, cloud services, and 5G, optical networks are becoming indispensable due to their high-bandwidth and low-attenuation properties. Silicon photonics, often manufactured with SOI processes, play a crucial role in expanding network speeds and coverage. These technologies cater to a wide range of applications, including telecom infrastructure, consumer electronics, and automotive communication systems.

As telecom operators expand their infrastructure, monitoring trends in edge computing and optical networking will be essential for buyers. Understanding these shifts can help mitigate risks and capitalize on opportunities, ensuring alignment with both current and future demands.

As connectivity infrastructure advances, securing stable supply for these specialized chips will be critical.

An additional telecom trend to watch is the adoption of more advanced generations of wireless connectivity. Adoption of new Wi-Fi technologies—known as Wi-Fi 6 and 6E—has grown incrementally, driven by the increased demand for enterprise digitalization, cloud computing, AI, and remote-work capabilities.

Wi-Fi 6E penetration is expected to reach 32 percent by 2025, as telecom providers integrate the technology into household routers, especially in the US. The ongoing adoption of Wi-Fi 6 and 6E has begun to influence semiconductor-manufacturing processes. Initially produced at 28nm nodes, some Wi-Fi 6 chips have transitioned to 16nm FinFET processes due to supply chain disruptions during COVID-19.

Meanwhile, Wi-Fi 7—which was finalized in January 2024—will ultimately support three frequency bands and deliver faster data rates. This technology will push demand for 14nm nodes as routers and network infrastructure evolve, marking a potential shift in semiconductor manufacturing priorities. However, widespread adoption of Wi-Fi 7 will depend on infrastructure readiness and the gradual integration of network-compatible devices.

Edge computing and optical networking are reshaping semiconductor needs, with telecom operators investing in SOI-based silicon photonics.

Medical equipment

The final industry we're going to review in this report is the medical equipment sector. Here, a trend to watch is the rise of portable and wearable medical devices, such as cuffless and non-invasive monitors for conditions such as high blood pressure and excessive glucose levels.

The need for these devices, which have become far more advanced and effective in recent years, is driven by the need for less intrusive solutions and enhanced patient quality of life. They stand to reshape how healthcare is delivered for millions of people.

The underlying technology enabling this shift is the integration of connectivity and on-device computing within these devices. By incorporating semiconductors capable of performing localized processing, while maintaining low power consumption, manufacturers are meeting growing patient and healthcare provider demands for reliable, efficient, and cost-effective solutions.

Such technologies are reshaping semiconductor demand in healthcare, which means a likely boost for mature-node demand. As shown in figure 18 on page 31, the sector relies heavily on >90nm mature nodes, known for their balance of power efficiency and processing capability—essential qualities for medical equipment.

Unlike industries that rapidly adopt cutting-edge technologies, the medical sector must prioritize stability and regulatory compliance. This dynamic means that manufacturers may continue to depend on older semiconductor technologies long after they are phased out in other sectors. As a result, ensuring availability over the extended life cycle of medical devices becomes paramount.

The reliance on mature-node semiconductors in medical devices, driven by long product life cycles and cost considerations, is risky. While these nodes remain suitable for the needs of portable medical devices, such as wearable monitors and diagnostic tools, their reduced competitiveness compared to advanced nodes increases the danger of obsolescence.

That danger is an acute one for medical equipment buyers. Unlike consumer devices, medical equipment has long product life cycles, making it vulnerable to disruptions in mature-node supply as foundries prioritize other high-volume industries. Buyers must strategically plan for long-term semiconductor availability, ensuring stable sourcing strategies to mitigate potential supply shocks.

Compounding this issue is the sector's overreliance on field-programmable gate arrays (FPGAs), components that were heavily disrupted during the COVID-19 pandemic and still remain difficult to source due to a highly concentrated, duopolistic supply base. This exposure highlights the need for strategic sourcing and long-term component planning to avoid future disruptions.

Then there's the emergence of AI, which stands to transform the medical field. As this technology advances, it promises to improve diagnostic accuracy and patient outcomes. The medical sector's connectivity requirements are also expanding, driven by the need for seamless data integration and real-time monitoring.

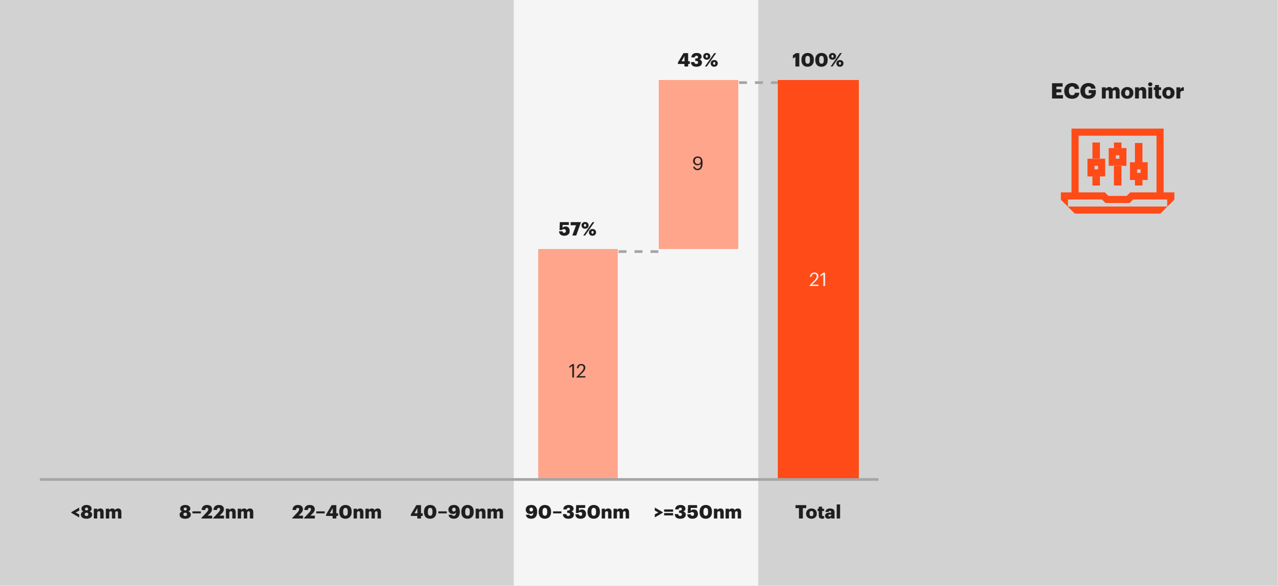
These advances in AI and connectivity will increase the need for power-efficient processors and specialized analog chips, as well as for the platforming and modularity approaches required to enhance device interoperability and adaptability. As a result, manufacturers must navigate the delicate balance between adopting new technologies and maintaining the high levels of stability and regulatory compliance that are so essential for the healthcare sector.

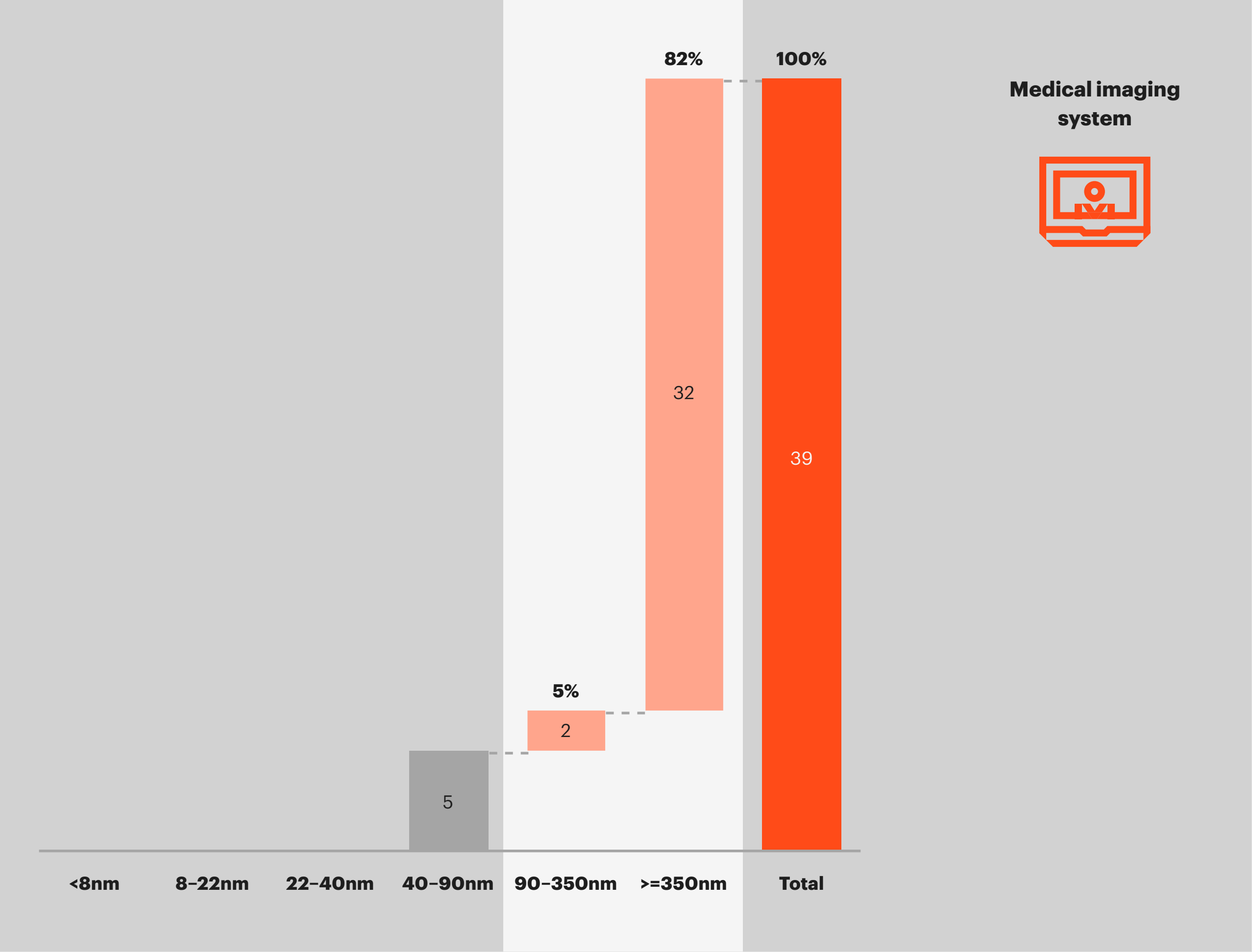
Figure 18

Critical medical products are primarily composed of >90nm node components

Wafer composition by device

200mm wafer per thousand products, 2024





Source: Kearney analysis

Geopolitical fault lines

How did we get here?

For decades, companies focused on getting the cheapest parts as fast as possible, creating a complex, far-flung supply chain. Then came the pandemic, exposing the weak spots of this arrangement. It quickly became clear that semiconductor supplies were quite vulnerable to supply disruptions, as seen in the automotive chip shortage.

But this was all just a foretaste of a new era of geopolitical instability in world trade generally, and in the semiconductor trade especially. With rising international tensions, the semiconductor industry, the brains behind all modern tech, has become a leading target for government intervention.

The bottom line is that geopolitics have fully emerged as a crucial determinant of semiconductor supply. The semiconductor industry is confronting a new era shaped by protectionist policies and economic nationalism.

How the industry reacts—by redistributing production, embracing these new policies, or some unforeseen strategy—will determine not only its own future, but the future of virtually every other sector in the modern economy.

To understand how we've reached this point, it's worth taking a moment to look at the fraught relationship between the world's two largest national economies: those of the United States and the People's Republic of China (PRC).

The US and China are locked in a high-stakes battle for semiconductor dominance. The US has the edge in design and tools, but China is pouring resources into catching up, especially in AI and advanced chips.

To counter China's advances in this critical and highly sensitive technology, the US government has deployed a variety of policies, some of which are listed in figure 19. These export restrictions and related measures have limited China's access to cutting-edge fab equipment; as a result, the PRC currently accounts for less than 10 percent of global capacity at the advanced edge.

In recent months, the economic relationship between the US and China has become increasingly defined by shifts in tariff policy. The Trump administration's proposed "liberation day" tariff framework—featuring a 10 percent baseline rate across multiple countries, more than 30 percent on targeted nations, and more than 100 percent specifically on Chinese semiconductors—disrupted strategic planning and made investors nervous.

While the implementation of these measures remains on pause—with the US and China announcing on May 12 a deal that, at least for the moment, reduces tariffs for both nations—tensions between the two powers are unlikely to calm soon.

The South China Sea and Taiwan Strait are potential flashpoints, with high risk for supply chain disruptions. The US Indo-Pacific Command's leadership considers this the most dangerous environment in decades. Recent congressional testimony and reports from the Center for Strategic and International Studies (CSIS) show that a majority of surveyed US foreign policy experts (68 percent) believe a Taiwan crisis is likely, amid increased Chinese military violations of Taiwan airspace air-defense identification zone (ADIZ) and harassment of Philippine maritime vessels.

Semiconductor buyers must now prepare for a future in which trade policy is inseparable from core supply chain design. Procurement decisions can no longer rely solely on traditional cost and delivery metrics—they must now account for geopolitical risk as a first-class constraint.

Figure 19
The semiconductor industry has become a target for government intervention

① **April 9, 2022:** The United States passes $52 billion of local semiconductor incentives with the CHIPS Act.

② **October 7, 2022:** The United States restricts Chinese access to labor, sales, people, and tools for AI.

③ **July 3, 2023:** China restricts key metals from export to the United States without licenses.

④ **August 9, 2023:** The United States imposes restrictions on outbound investment into Chinese semis.

⑤ **March 25, 2024:** China adopts rules to ban AMD and Intel from government devices.

⑥ **January 1, 2025:** The United States passes 50% tariff on Chinese semis (Biden administration).

⑦ **March 5, 2025:** President Trump suggests lawmakers get rid of the CHIPS Act.

⑧ **March 12, 2025:** TSMC announces $100 billion US semi manufacturing and potential Intel joint venture.

Source: Kearney analysis

Emergent truths of supply chain bifurcation and disruption

All of this means that four hard truths are emerging for buyers:

1. The bifurcation of supply chains is no longer a hypothetical possibility—it's the new reality.

   A structural divide is rapidly forming between Eastern and Western semiconductor ecosystems. The United States is doubling down on reshoring efforts fueled by CHIPS Act incentives and regional manufacturing alliances, while China is aggressively investing in fabs and process equipment to secure domestic supply chains.

   Pressure from the Communist Party of China (CPC) for mainland self-sufficiency in technology may favor local suppliers, such as SMIC and YMTC, over multinational competitors. Recent CPC announcements, such as banning Intel and AMD semiconductors in government devices, highlight this trend.

   This emerging bifurcation is reshaping supplier landscapes, particularly for buyers with significant exposure to Asia Pacific manufacturing. Firms that source from Chinese foundries or contract manufacturers now face real and growing risks—from sudden cost shocks to politically driven export restrictions.

   Meanwhile, US-based manufacturers may benefit from a temporary pricing or availability advantage. However, they are already running into physical limits around fab capacity and skilled labor availability.

   The labor shortfall may prove to be a matter of particular concern. Even as foundries announce aggressive capacity-expansion plans, the industry faces a growing shortage of skilled talent to build and operate fabs. Semiconductor manufacturing requires highly specialized engineers and technicians, and supply has not kept up with the surge in new fab projects.

   TSMC's struggles in ramping up production at its Arizona facility highlight the difficulty of transplanting semiconductor expertise to new regions. Many of these challenges stem from a lack of experienced process engineers and the complexity of training a workforce accustomed to different manufacturing standards. Without a steady pipeline of skilled workers, fab construction timelines could face delays, and new facilities may struggle to reach full operational efficiency.

2. Complexity becomes the new cost driver as inventories split.

   For buyers, all of this bifurcation of supply chains demands a rethinking of how—and where—critical components are sourced, with supply continuity and compliance now as important as unit cost. This involves mapping your product from a node and geography exposure down to die family level and ensuring at least one "East" and one "West" path for each critical component.

   In an effort to navigate export restrictions and comply with divergent trade regimes, semiconductor firms are beginning to bifurcate their product lines by geography. Fabless players such as NVIDIA and AMD are creating separate SKUs for China and the West, fragmenting demand and creating a cascade of complexity for downstream buyers.

   NVIDIA's recent experience illustrates the volatility of this strategy. The company developed the H20 GPU to comply with US export rules for China, only for that variant to be swept up in a subsequent round of restrictions. NVIDIA is now working on yet another China-compliant product—a cycle that adds cost, slows qualification timelines, and erodes volume-based pricing leverage.

   For procurement teams, this proliferation of region-specific SKUs undermines substitution flexibility, complicates inventory planning, and increases the need for separate compliance tracking and supplier negotiations. Complexity, rather than cost alone, is becoming the primary management challenge.

3. Chinese fabs are raising price pressures on mature nodes.

   Amid the industry's focus on advanced-node technologies, the concentration of mature-node production in China has quietly emerged as one of the most significant risks.

   Today, roughly 20 percent of global mature-node capacity (40nm and above) resides in China, and that share is expected to rise above 30 percent over the next five years. As noted above, China is aggressively investing in domestic production, and could potentially flood the market with cheaper alternatives, pressuring competitors.

   This could have significant consequences for the mature chip market (>22nm), which underpins vital technologies such as 5G and image processing, and represents a significant portion (70 percent) of total semiconductor demand.

   The result is rising price pressure for major segments such as PMICs, analog chips, and automotive microcontrollers—products that are deeply embedded in long-life systems and often take years to requalify.

   For fabless firms and system integrators with deep exposure to Chinese foundries, tariffs on these devices could push landed costs higher by 10 to 20 percent, depending on the component and volume structure. Unlike advanced-node chips, mature-node devices are not easily migrated to new fabs due to differences in tooling, design libraries, and package dependencies.

   This dynamic places an especially acute burden on buyers to diversify in the automotive and industrial sectors, where component redesigns and qualification cycles are slow-moving and capital-intensive.

4. Second-order effects include disruptions of capital equipment and raw materials.

   Beyond direct tariffs on finished semiconductors, buyers must also contend with upstream disruptions in capital equipment and raw materials. Semiconductor fabrication remains deeply reliant on globally distributed toolsets and specialty materials, many of which are now subject to export controls and retaliatory trade measures.

   The curtailment of EUV tool shipments to China has helped Western and Taiwanese fabs maintain their competitive edge. Meanwhile, China's restrictions on critical raw materials such as gallium and germanium—essential inputs for RF and power devices—pose a growing threat to global wafer and packaging supply. As noted previously, such moves have already begun to impact high-growth segments such as AI accelerators and electric vehicle platforms, where materials like GaN are integral to performance.

   While equipment suppliers with vertically integrated operations, such as ASML, are somewhat buffered from global shocks, even they face rising costs and scheduling pressures as geopolitical constraints mount.

   These second-order effects—reduced tool availability, rising material input costs, and longer lead times—will ripple through the market, affecting buyers indirectly but materially.

Future geopolitical scenarios

The way governments are influencing the semiconductor industry is complex and ever-changing. Tariffs and economic nationalism have transformed the calculus for semiconductor sourcing. The path forward demands strategic realignment across multiple dimensions: node-level exposure, supplier geography, design flexibility, and contract structure.

To better understand all of this, and to predict where things might be headed, we can use a scenario-planning approach. Earlier in this report, we laid out potential scenarios for supply chain capabilities. Here, we're going to explore a different set of future scenarios, focusing on potential geopolitical outcomes.

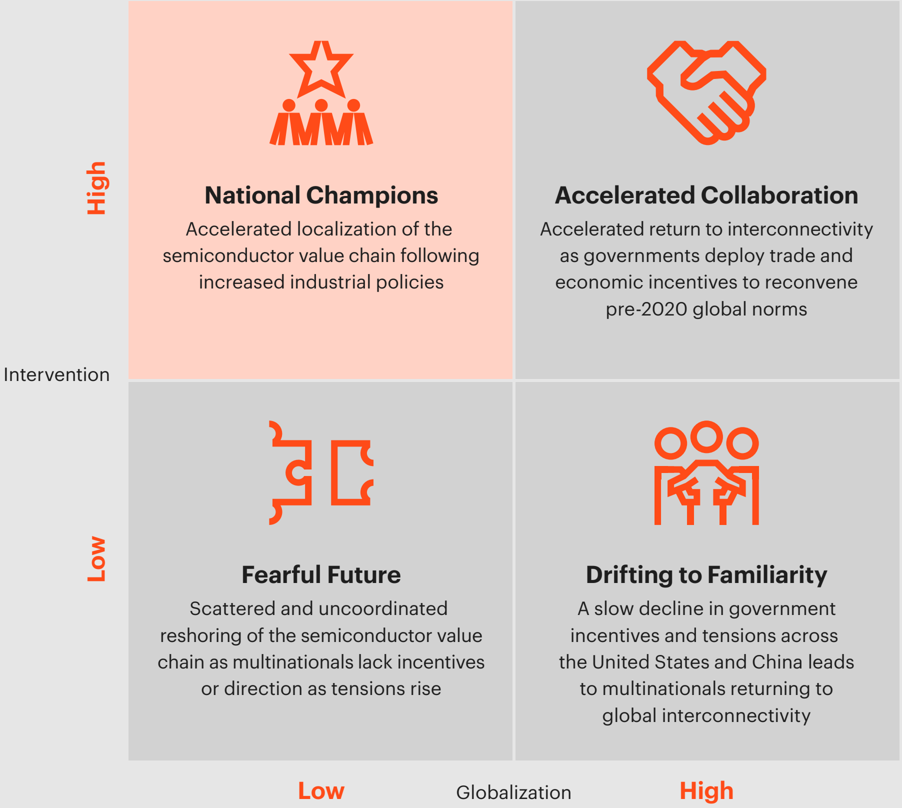
This means mapping out different possibilities based on two factors: how much governments get involved (intervention), and how globally dispersed production will become (globalization).

By looking at these two factors together, we can identify different futures for the industry, each with its own set of advantages and disadvantages. Imagine it like a chessboard: depending on how governments move their pieces (intervention) and how companies manage their supply chains (globalization), the game can play out very differently, as shown in figure 20.

We will now explore these different scenarios and what they could mean for the global semiconductor market. For each scenario, we lay out expectations, potential impacts, and suggestions for how companies might most effectively respond.

Figure 20

Four scenarios reveal how the semiconductor industry could evolve



National Champions

Accelerated localization of the semiconductor value chain following increased industrial policies

Accelerated Collaboration

Accelerated return to interconnectivity as governments deploy trade and economic incentives to reconvene pre-2020 global norms

Fearful Future

Scattered and uncoordinated reshoring of the semiconductor value chain as multinationals lack incentives or direction as tensions rise

Drifting to Familiarity

A slow decline in government incentives and tensions across the United States and China leads to multinationals returning to global interconnectivity

Source: Kearney analysis

Scenario 1: National Champions

Governments focus on developing self-reliant domestic semiconductor industries, driven by nationalism, security concerns, or a desire to decouple from foreign technology. This involves heightened government intervention, in the form of policies that promote domestic production and potentially restrict foreign competition. Supply chains become more localized, potentially within regions or even individual countries.

Countries across the globe are trending toward this scenario. Take, for example, the "Made in China 2025" initiative, which aims for self-sufficiency in chip production; or South Korea's $19 billion support package for the chip industry, announced in May 2024.

In the US, there are growing investments to boost domestic chip production: the CHIPS Act, passed in 2022, aimed to attract investment from semiconductor companies. While funding was allocated throughout 2023 and 2024, companies are now positioned to start spending.

TSMC announced a $100 billion investment for five facilities over four years after a promised $7 billion in government funding; GlobalFoundries unveiled plans for an advanced packaging and photonics center in New York after a promised $2 billion in public funding.

However, President Trump has voiced disdain for the CHIPS Act, suggesting lawmakers get rid of it. This represents a departure from the "carrot" mentality of the prior administration, moving toward more of a "stick" motivator. Now semiconductor players will have to consider tariffs, trade barriers, or threats of revoking funding as they make long-term investment decisions.

Expectations

1. **Early value chain likely to be disrupted.** Limited access to electronic design automation (EDA) tools and intellectual property (IP), the essential building blocks of chip design, can hinder domestic capabilities. For example, China's struggle to develop domestic EDA tools that match the maturity and functionality of established players, such as Synopsys and Cadence, could limit its ability to create high-performance chips.

2. **Localized, redundant ecosystems.** Replicating the technological expertise and production efficiency of fabs, such as those operated by TSMC, would be a significant hurdle. For example, despite heavy investments in domestic fabs through companies such as Samsung, South Korea still struggles to match TSMC's dominance in logic-chip production, which is critical for processors.

3. **Domestic OSAT challenges.** Encouraging domestic companies to handle outsourced semiconductor assembly and test (OSAT) functions can ensure end-to-end control within a national market. However, domestic OSAT providers may initially lack the experience and infrastructure of established international providers, leading to capacity constraints and quality issues.

   For example, US start-ups aiming for domestic OSAT capabilities often face these challenges, struggling to match the quality control and production efficiency of established players such as ASE of Taiwan.

Industry impacts

Companies located in countries promoting domestic production could benefit from government subsidies and incentives under this scenario, while companies heavily reliant on foreign technology and globalized supply chains could face disruptions and increased costs due to potential restrictions and fragmentation.

This scenario would lead to a vicious cycle—accelerating fragmentation; slowing the pace of innovation as suppliers focus on domestic markets; shrinking the global talent pool; and likely increasing costs and total production time due to inefficiencies.

How can companies respond?

Companies can actively participate in government programs to build domestic capabilities in EDA tools, semiconductor manufacturing equipment (SME), and advanced fabs, while forging partnerships with domestic suppliers to reduce reliance on foreign technology.

Scenario 2: Accelerated Collaboration

This scenario is driven by a geopolitical realignment, a fierce technological race among leading nations, and the need for next-generation chip development.

Here, governments actively guide the industry through R&D funding and strategic partnerships with other nations. This fosters a globally competitive market, with international research collaboration and potential trade agreements to ensure the smooth flow of resources.

This scenario mirrors the US–Japan relationship in the 1980s and 1990s, when collaboration spurred innovation, despite trade tensions. While potential disruptions persist, continued globalization could accelerate technological advancements.

Expectations

1. **Faster innovation cycles.** A globally interconnected semiconductor sector fosters a rapid exchange of knowledge, accelerating innovation in chip design. This can lead to quicker development of new chip technologies and faster time-to-market for products. For example, the European Chips Act allocates billions of euros to support joint research efforts among European countries, and potentially with other global partners.

2. **International cooperation.** Sharing expertise and resources across borders allows researchers to tackle complex challenges in chip design and manufacturing more effectively. This collaborative approach would lead to breakthroughs that might not be achievable by individual countries working alone.

   For example, discussions between the US and Japan to explore a joint agreement for a stable supply of raw materials for chip manufacturing highlight the growing focus on international collaboration to address critical issues in the chip sector.

3. **Shifted foundry landscape.** While TSMC will likely retain dominance, particularly as it specializes in certain advanced processes, it will face increased competition from new players emerging within regional foundry partnerships.

   This could lead to a more geographically dispersed foundry network, with TSMC potentially opening local foundries to stay close to customers and potentially benefit from government support. The overall market will become more competitive, but also potentially more efficient, with each region playing to its strengths.

Industry impacts

Under this scenario, governments act as facilitators, guiding research consortiums and fostering a globally competitive market. This collaborative environment would accelerate innovation cycles and breakthroughs, fueled by a diverse global talent pool. Companies that embrace this shift will thrive, gaining access to cutting-edge research and expertise. Conversely, those clinging to domestic production risk falling behind.

How can companies respond?

Companies that actively participate in this collaborative environment can gain a competitive edge by securing access to the latest advancements, a broader talent pool, and potentially to increased government funding for research. For example, companies involved in the Semiconductor Research Corporation (SRC) consortium were able to stay at the forefront of chip technology due to their access to collaborative research findings.

Conversely, companies should avoid over-relying on domestic production, which could slow innovation, curb access to advanced technologies, and limit opportunities to leverage the government funding and expertise that might be available through international collaborations.

Scenario #3: Fearful Future

This scenario is characterized by rising nationalism, economic isolationism, and technological decoupling among major economies. Here, minimal government intervention combines with a shift toward localized production. This limited collaboration could resemble protectionist policies adopted by some countries after World War I or during the 1970s oil crisis.

While this approach might bolster national security, it could significantly fragment the global semiconductor industry, leading to regionalized supply chains that are potentially more inefficient and less innovative than a more collaborative global market might be.

Expectations

1. **Stifled innovation.** Limited access to the best design tools and intellectual property hinders innovation and slows down the development of advanced chips. This could lead to a situation in which entire regions fall behind in the global technological race. For example, the Soviet Union's isolation during the Cold War hampered its ability to keep pace with Western advancements in chip design. This ultimately left it lagging in overall technological development.

2. **Disrupted supply chain.** Economic isolationism disrupts the flow of essential equipment used in chip manufacturing. Shortages and bottlenecks inevitably arise, hindering production. Domestic manufacturers, struggling to meet demand due to limited access to global resources, exacerbate chip shortages across the board. Recent chip shortages demonstrated the downsides of this scenario, highlighting the global nature of the semiconductor supply chain and proving that disruptions in any one region can have cascading effects on production worldwide. A further turn toward isolationist policies could exacerbate these issues.

3. **Inefficient fabs and foundries.** Without international collaboration and access to advanced manufacturing technologies, domestic fabs would struggle to compete with established players such as TSMC. This isolation could lead to inefficiencies, higher production costs due to a lack of economies of scale, and a potential shortage of high-quality chips globally. For example, despite heavy investments in domestic fabs, companies such as South Korea's Samsung still struggle to match TSMC's dominance in logic-chip production.

Industry impacts

Talent and ideas would be confined by borders. Isolated regions might develop niche expertise in specific chip types but fall behind in others. This fragmentation could birth regional champions, but at the cost of global stagnation, higher production costs, and potential shortages—harming not just the semiconductor industry, but all sectors that rely on advanced chips.

How can companies respond?

Companies could invest heavily in developing domestic alternatives, which could be costly and time-consuming. For example, Huawei, facing US sanctions, had to invest heavily in developing its own chip-manufacturing capabilities.

Furthermore, companies could relocate operations to regions with more open and collaborative chip sectors. This could involve moving design centers or fabrication facilities to countries with less restrictive policies. In the end, companies that can successfully navigate the fragmented landscape and develop strong domestic capabilities might emerge as regional players.

Scenario #4: Drifting to Familiarity

This scenario depicts a future fueled by minimal government intervention and a focus on cost efficiency. This fosters highly globalized supply chains, in which companies draw upon global talent pools and geographically dispersed production for optimal resource allocation. This scenario mirrors the post-Cold War era, when free-trade agreements such as NAFTA facilitated a thriving, globalized semiconductor industry.

Expectations

1. **Faster innovation.** A fiercely competitive landscape fueled by access to a global talent pool and resources sparks innovation. Companies gain access to the latest advancements in design tools, IP, and components, leading to efficiency in chip development and faster time-to-market.

2. **Collaborative innovation.** Collaboration between designers and suppliers across borders becomes commonplace, driven by the shared goal of cost optimization. This fosters a more interconnected industry, in which advancements benefit all participants. The close collaboration between chip designers and manufacturers in developing advanced-edge GPUs is an example of how international partnerships can drive innovation.

3. **Efficient supply chain.** A globalized market for essential equipment used in chip manufacturing fosters innovation and reduces costs. Companies benefit from a wider range of cutting-edge equipment from international suppliers, leading to advancements in SME technologies at lower prices.

4. **Retained foundries dominance.** Established foundries, such as TSMC, maintain dominance due to open markets facilitating access to advanced manufacturing technologies.

5. **Cost-effective OSAT services.** Companies leverage the expertise and infrastructure of established international providers for OSAT services. This avoids the potential downsides of domestic-only solutions, such as capacity constraints or quality issues. For example, companies such as Amkor Technology, a global leader in OSAT services, provide essential back-end manufacturing capabilities to a wide range of chip designers around the world.

Industry impacts

This scenario paves the way for a dynamic and highly efficient industry, but success will hinge on companies' ability to navigate the global landscape, build strong partnerships, and prioritize cost optimization throughout the entire production chain.

How can companies respond?

Companies that can effectively leverage the global talent pool and resources will be well-positioned for success. This includes building strong partnerships with international suppliers and collaborators. Additionally, companies that prioritize cost optimization and efficiency throughout the design and manufacturing process will gain a competitive edge.

The path forward demands strategic realignment across multiple dimensions: node-level exposure, supplier geography, design flexibility, and contract structure.

Conclusion: Securing the future

The developments described in this report all add up to a new operating reality for procurement leaders. As semiconductor demand evolves and supply chains adapt, buyers must shift from reactive procurement to long-term resilience planning. That's because supply resilience is no longer a reactive discipline—it must be proactively embedded into every sourcing decision.

We will conclude with four basic principles to guide organizations in building a resilient semiconductor supply chain. Obviously, the details on how to enact these principles could fill entire reports all by themselves, but we offer these as broad tenets for steering in the right direction.

— **Recognize the true nature of supply constraints.**

Overcorrections from past shortages have led many buyers to assume that we are now in a world of long-term supply stability. However, AI adoption and EV expansion are driving concentrated demand in <8nm and 90nm–350nm nodes, categories where capacity constraints remain all too real.

Those constraints will not follow the same script as the COVID-era shortages. Instead, they will emerge from structural imbalances. While wafer-capacity issues dominate short-term discussions, long-term semiconductor supply challenges extend beyond fabs.

Bottlenecks in such critical areas as lithography equipment, advanced packaging capacity, and skilled fab talent are poised to shape industry dynamics in the coming years. These constraints are becoming as critical as wafer supply itself, potentially shifting the balance of value creation across the supply chain. In this climate, buyers must shift from reactive sourcing to multi-year strategic planning, ensuring supply security without overstocking in non-critical areas.

— **Drive product designs that enable resilience.**

The first—and often overlooked—line of defense against semiconductor shocks is the product design itself. Savvy manufacturers lock in proven silicon across multiple generations; limit moves to new nodes or packages to only the few chips that create visible performance gains; and qualify secondary sources during the design phase.

Apple's latest iPhone refresh illustrates this strategy at scale. As illustrated in figure 21, more than 80 percent of the major ICs in the iPhone 16 are identical to those in the iPhone 15, spanning RF front ends, PMICs, Wi-Fi and Bluetooth modules, NAND flash, and envelope trackers.

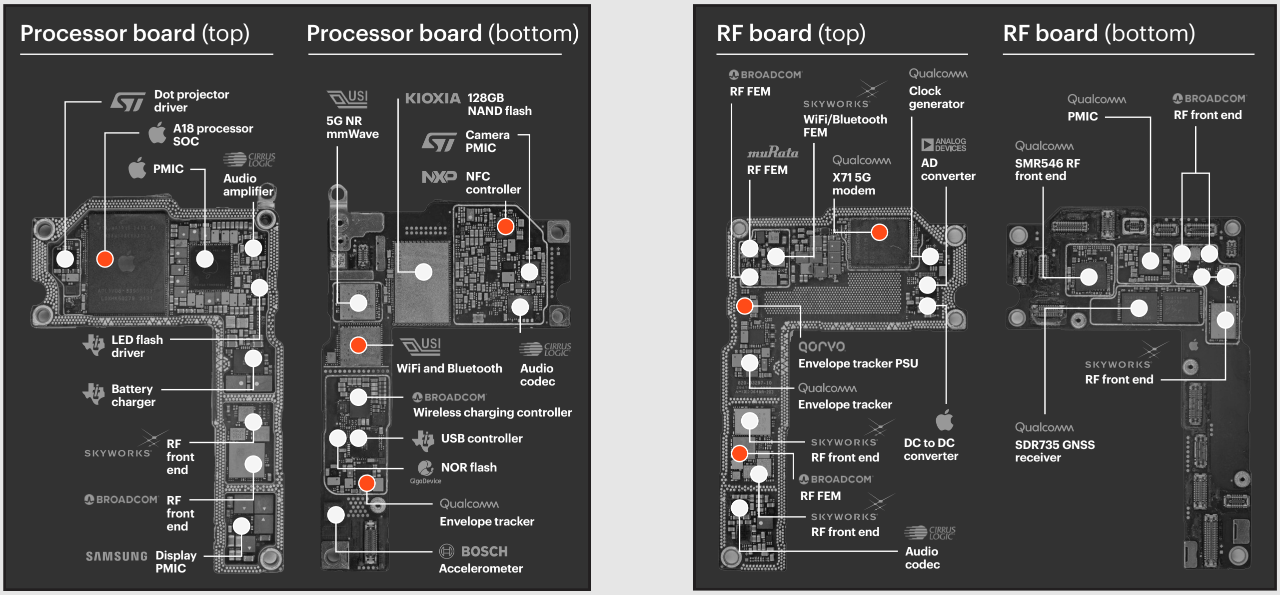
By freezing most of the bill of materials while upgrading only the A18 SoC and a handful of camera-related parts, Apple cut re-qualification time, secured multi-year capacity commitments from suppliers, and avoided node-specific bottlenecks. It's an example worth emulating at a time of unpredictable supply limitations.

Figure 21

More than 80% of the major chips in an iPhone 16 are unchanged from iPhone 15, increasing gen-over-gen supply chain resilience

Major chip suppliers for iPhone 16

● New part number for iPhone 16



Source: Kearney analysis

- **Optimize supply chain for resilience and cost**

  The lowest-cost, just-in-time supply chains of the past have proved to be fragile under disruption—and we're in for much more potential disruption to come.

  The bifurcation of supply chains, geopolitical risks, trade policies, and localized investments will influence availability and pricing. Meanwhile, reshoring and regionalization efforts are raising costs, forcing companies to balance redundancy with efficiency.

  While capacity expansions are under way, and foundries are exercising greater capital discipline, cost optimization alone is no longer a viable approach. Resilience is now a competitive advantage—and to achieve it, advanced players are diversifying suppliers, securing long-term agreements, and investing in dual-sourcing strategies for key components.

- **Prepare for a fragmented semiconductor ecosystem**

  As mentioned earlier, the semiconductor industry is no longer a unified global marketplace. China's dominance in mature nodes and Western control over advanced nodes are creating two parallel supply chains. Advanced-edge manufacturing is increasingly concentrated in Taiwan, the US, and South Korea, while China is expanding its foothold in 40nm–90nm production.

  Companies must assess their exposure to these two bifurcated markets, ensuring access to critical technologies while also maintaining optionality in their supply chains. Buyers who invest in dual-path sourcing, tariff-indexed contracts, and scenario-based planning will be better positioned to absorb cost shocks, navigate disruption, and maintain continuity in an increasingly fragmented industry landscape. Those who do not may find themselves squeezed by rising costs, shrinking options, and diminishing leverage.

As the industry evolves, semiconductor buyers must remain vigilant—navigating not just node-level constraints, but the broader supply chain shifts that will define the next decade of semiconductor manufacturing.

Multi-sourcing, long-term capacity reservations, and deeper supplier partnerships are now table stakes rather than differentiators. To navigate this landscape, buyers must diversify supply sources, secure long-term agreements, and anticipate shifts in competitive dynamics.

Firms that treat packaging as a capacity constraint, hedge against geopolitical risk, and proactively secure long-term supply at critical nodes will be best positioned to succeed. As AI demand accelerates, mature nodes remain critical and geopolitical tensions persist, the most prepared buyers will secure not just chips—but a lasting competitive edge.

> Firms that treat packaging as a capacity constraint, hedge against geopolitical risk, and proactively secure long-term supply at critical nodes will be best positioned to succeed.

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