

The Pulse of the Semiconductor Industry

Balancing resilience with innovation

Introduction

Semiconductor companies are at the center of technology innovation, finance, geopolitics, and human ingenuity, touching virtually every aspect of business and people's lives. The past few years, however, have been far from smooth sailing. The industry is still reeling from the chip shortage crisis, and manufacturers are challenged to create greater resiliency due to continually increasing demands on an already fragile supply chain.

Semiconductor companies also face headwinds like geopolitical conflicts disrupting energy supplies, record economic inflation, recession fears, with a tight labor market that's making it difficult for companies to recruit and retain skilled talent.

Battling disruptions on multiple fronts can complicate semiconductor companies' efforts to achieve their growth goals. But the opportunities are there. New research from Accenture (see box, ["About the Research"](#)) explores some of the challenges the industry faces, provides an industry outlook for today and tomorrow, and highlights opportunities to capitalize on emerging growth opportunities.

We surveyed 300 global semiconductor executives for their insights on:

- 01** The state of the industry today;
- 02** The technology and product outlook for the two years;
- 03** The role of semiconductors in each.

Our study explored four select technologies and end-user applications that have clear growth potential for semiconductor companies to enhance their business and offerings:



Metaverse

See more

67% of executives agree that semiconductors are the capability most critical to the metaverse's development.

28% of respondents view the metaverse as the most likely among these technologies to achieve commercialization at scale in the next two years.



Sustainability

See more

37% of respondents believe sustainability will likely play the largest role in the semiconductor value chain within the next five years.

64% of executives believe they can achieve carbon neutrality within two years.



Mobility

See more

93% of executives think motor vehicle manufacturing companies should partner with technology companies on next-generation mobility.

A majority of respondents viewed semiconductor design firms or integrated device manufacturers as the ideal partner.



Digital health

See more

28% of respondents believe wearables will benefit the most from continued semiconductor innovation.

36% of executives think wearables are already having a significant impact on improving health.

These four areas were selected for two reasons¹:

- 01** They represent the key influential technologies identified by CES (Consumer Electronics Show) analysis as those that offer the greatest potential to advance our work and life; and
- 02** Regardless of country, these are among the top priorities across the global semiconductor industry.

¹ "CES 2022 Analysis: Themes That Will Influence How We Work and Live in 2022 and Beyond" Serious Insights 01/10/2022

The future

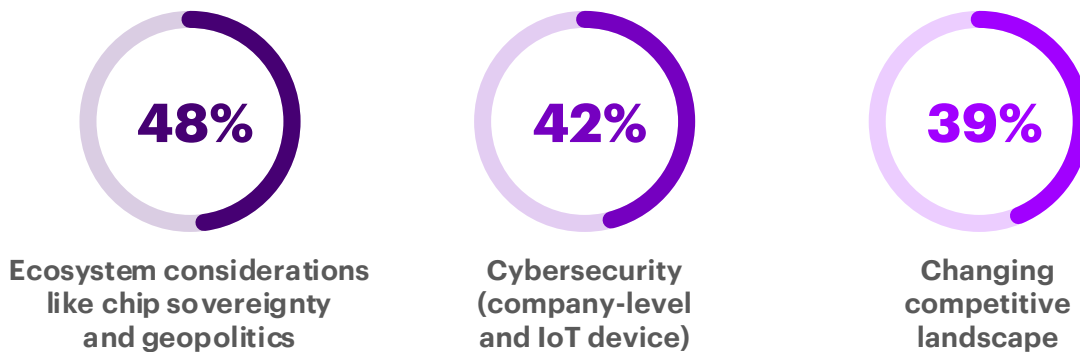
Before diving into the four focus areas, let's highlight what semiconductor executives think about the state of the industry today, and two years from now. We found almost 2 out of 3 (65%) executives believe that Moore's Law will slow down by 2025, potentially causing the semiconductor industry to balance innovation with resilience.

Inflation and economic concerns continue to be the top challenge for the semiconductor supply chain among executives surveyed (Figure 1). Furthermore, executives believe ecosystem considerations such as chip sovereignty and geopolitics will have the greatest impact on semiconductor innovation in the next 12 months (Figure 2). The pressures on the industry are real, and executives are focused on delivering industry stability. In fact, 56% of executives believe the best way to enhance the industry's resilience is by promoting strong IP protection and enforcement so companies can share technology while protecting their investment. They're also focused on technology-enabled innovation.

Figure 1: Greatest challenges for the semiconductor supply chain today



Figure 2: Factors with the greatest impact on semiconductor innovation in the next year

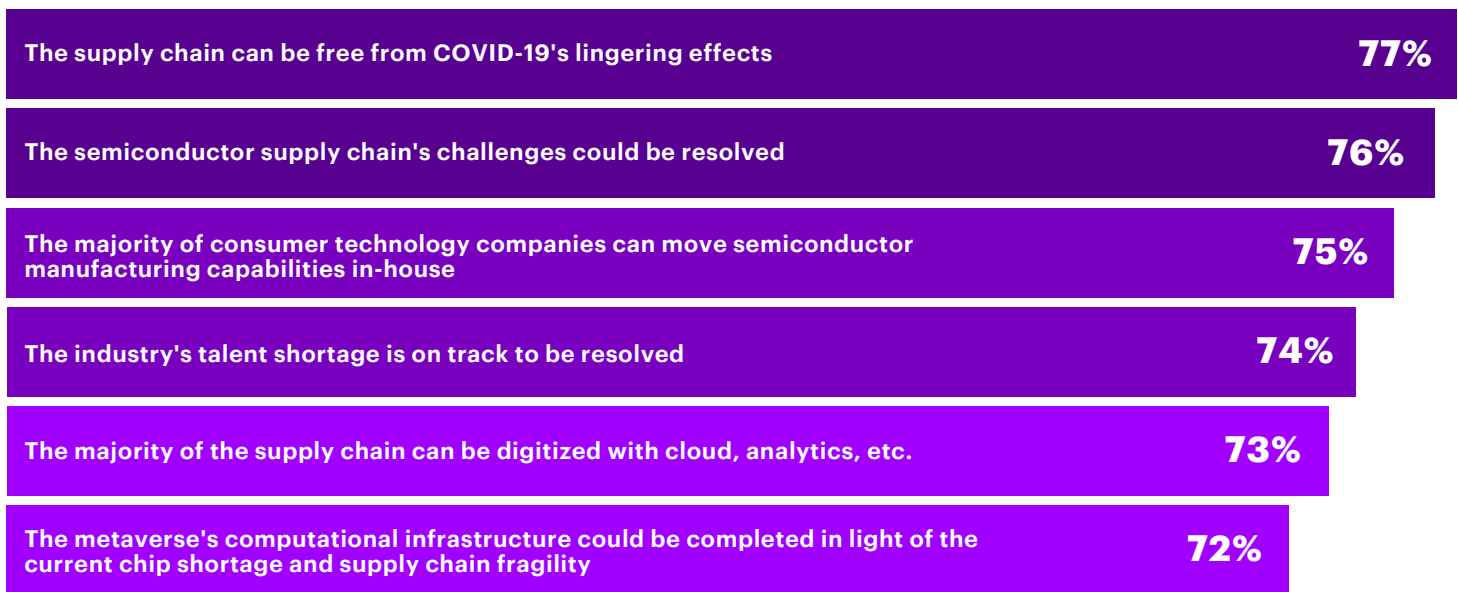


Executives also reported a more prominent role for artificial intelligence (AI)—both in the enterprise and in the semiconductor development process. One in two (50%) respondents said they are either deploying or scaling AI’s use in analytics, and just over half (52%) reported their company relies on an even balance between humans and AI in development. 21% indicated their companies rely mostly on AI in semiconductor development.

To help advance these technologies the industry is getting support with initiatives such as the CHIPS and Science Act which will advance the manufacturing, research and development and workforce development programs. In the US, over \$50 billion has been appropriated over the next 5 years to revitalize the industry with a 25% investment tax credit², while the European Chips Act will mobilize more than €43 billion of investments and set measures to react to future supply chain disruptions³. An investment of this type is invaluable for the industry and will provide sustenance for companies' future growth.

What does the future hold for the industry? Executives were remarkably consistent in their views. *Figure 3* illustrates their top predictions for the next two years. While there's no one defining issue, the supply chain is top of mind, slightly ahead of in-house chip manufacturing and the talent shortage.

Figure 3: How the semiconductor industry landscape may change by 2024



With these insights as the general backdrop for where the industry is today and where it’s headed, let’s explore what executives had to say about the four focus areas: **the metaverse, sustainability, mobility, and digital health.**

² [FACT SHEET: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China](#) The White House 08/09/2022

³ [European Chips Act](#) European Commission 02/08/2022



Metaverse



In the thirty years since the metaverse term was coined by science fiction writer Neal Stephenson, gradual advancements in technology promise to turn the concept into reality.

High Tech companies are building the infrastructure to create an environment that's ripe for access, engagement, consumption, and consumers.

What are the likely outcomes of the metaverse as the technology matures? A more-immersive work experience, including better hybrid work and improved online learning and education, were cited as the most likely outcomes by executives in our survey (Figure 4).

Figure 4: Likely outcomes of the metaverse as the technology matures



48%
Improving the hybrid work experience



47%
Improving online learning and education



43%
Delivering a more immersive experience

4 in 10

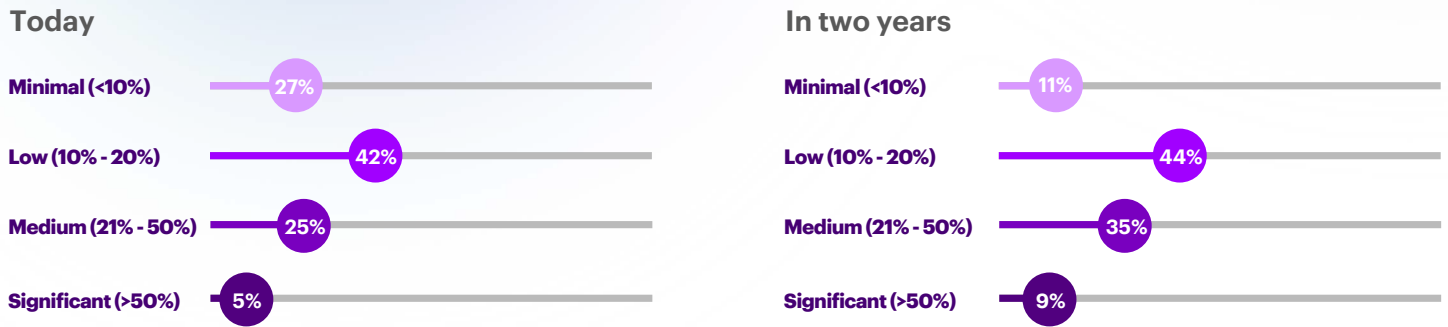
(42%) said the metaverse can create **new business opportunities**

1 in 4

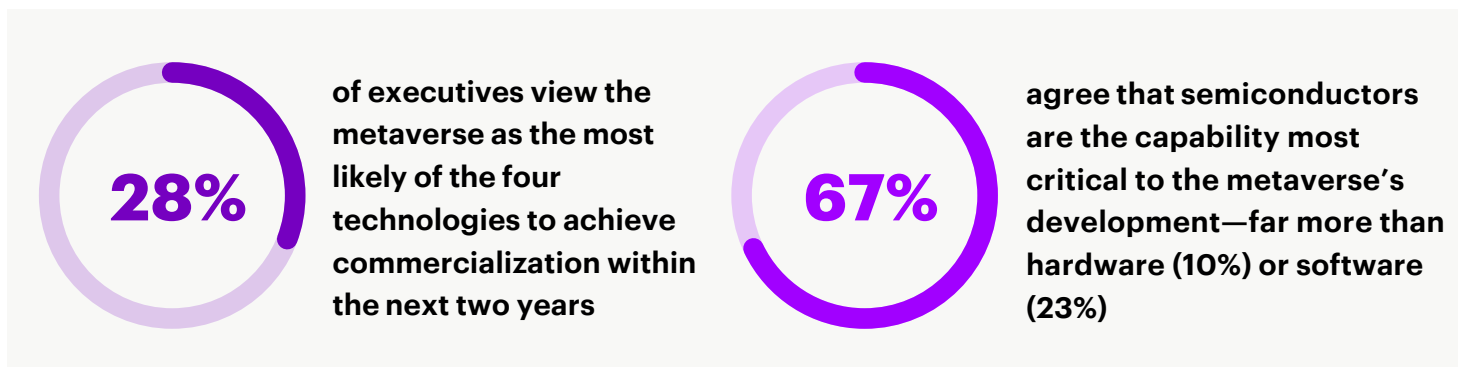
25% said the **metaverse** can play the largest role in the semiconductor value chain within the next five years or sooner

It's no surprise that semi companies are gearing up to capitalize on the metaverse, as evident in the expected jump in their production allocated to that space within the next two years (Figure 5).

Figure 5: Allocation of semiconductor production to the metaverse



The projected growth over the next two years can be attributed to the scaling of the metaverse, enabled by semiconductors.



Meeting that need will require technology innovation, which executives indicated is the biggest challenge for delivering custom semiconductors to metaverse companies—bigger than chip or talent shortages, or even the condition of the economy.

While 88% of executives said the potential the metaverse can bring to semiconductor companies is significant, the results may be unevenly distributed across the value chain (as it currently stands). For example, virtually all executives believe large-scale manufacturers that have the capacity to produce chips will benefit the most from the metaverse. There is, however, arguably less confidence in commercialization. We expect confidence will increase as we continue to understand what can be achieved technologically—so long as chip innovation continues.

Future success likely hinges upon extending beyond semiconductor companies legacy business to enable the value potential their customers' demand. They just need to think more creatively about how to do it.⁴

⁴ ["Hardware's New Reality: How High Tech can Find Greater Value in the Metaverse,"](#) Accenture 11/29/2022

Our take

Evaluate where to play in the larger metaverse value chain



The metaverse has entered the collective business and consumer consciousness, and there's no going back. Many companies have dedicated roles, offerings, and capabilities that allow them to be the first-to-market and lead experience drivers⁵. For semiconductor companies, their place in the metaverse is still in its infancy. They make the chips that power the devices and technologies. However, semiconductor companies are using the metaverse to focus on the value chain, allowing these companies to:



- **Apply R&D to engage in new capabilities**
- **Use existing capabilities in different ways**
- **Develop beyond their core chip business**

The goal is to tap into the more-lucrative segments of this exciting new space—including helping to build the platform and design the experiences that support the metaverse.

AMD is a great example. At their 2020 Financial Analyst Day, AMD focused on areas other than the metaverse. Fast-forward two years and one acquisition later, the company highlighted its “deep involvement” in the metaverse and “being at the forefront of where [it’s] going,” at their 2022 Financial Analyst Day. AMD arguably sees a multi-pronged opportunity across its IP portfolio by developing highly visual and immersive content and transforming the semi-custom business to offer customers new solutions. Today, the company is well-positioned as a metaverse enabler of products like data centers, near and edge computing and devices. It’s also the defacto standard for 3D content studios, gaming consoles, phones and PCs. Looking at what they accomplished in two years, the next two are likely to unlock even more innovation.⁶

⁵ “[Meeting in the Metaverse Require Chip Innovation](#),” Accenture High Tech Blog 07/13/2022

⁶ “[Financial Analyst Day](#),” AMD Investor Relations 06/09/2022. Content based on Accenture analysis.



Sustainability

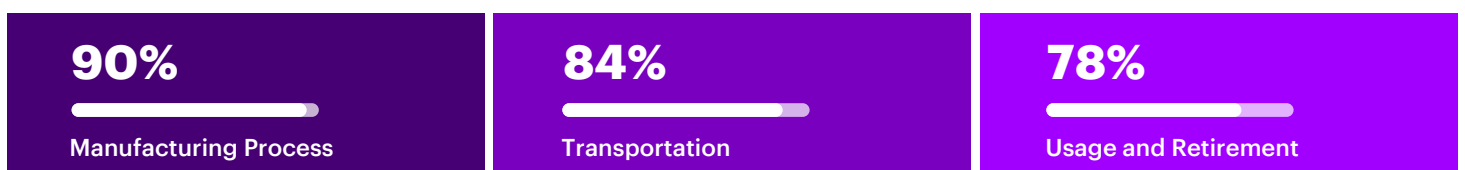
Sustainability is a critical issue for all companies, including those in the semiconductor sector. Growing chip demand requires increased production which, requires more power, water, and other natural resources.

For example, overall energy use in chip production has doubled every three years since 2010 and could consume nearly 20% of planetary energy by 2030⁷. If this rate continues, a large chip fab (fabrication) can use up to 10 million gallons of water a day, equivalent to the water consumption of roughly 300,000 U.S. households⁸.

Despite the sustainability challenges they face, semiconductor executives remain optimistic. 64% of semiconductor executives believe they can achieve carbon neutrality within two years.

In fact, of the four areas studied, sustainability is cited by the largest percentage of executives (37%) as most likely to play the biggest role in the semiconductor value chain in the future (e.g., within the next five years or sooner). Over 90% of executives agreed that more sustainable semiconductor practices can result in more sustainable consumer products, (94%) and sustainability initiatives can have a positive impact on profitability (93%). And, a large majority believe sustainability can be accurately measured not only in the consumer product lifecycle's manufacturing process and transportation, but also in product usage and device retirement (*Figure 6*).

Figure 6: Can sustainability be accurately measured across the following parts of the consumer product life cycle?

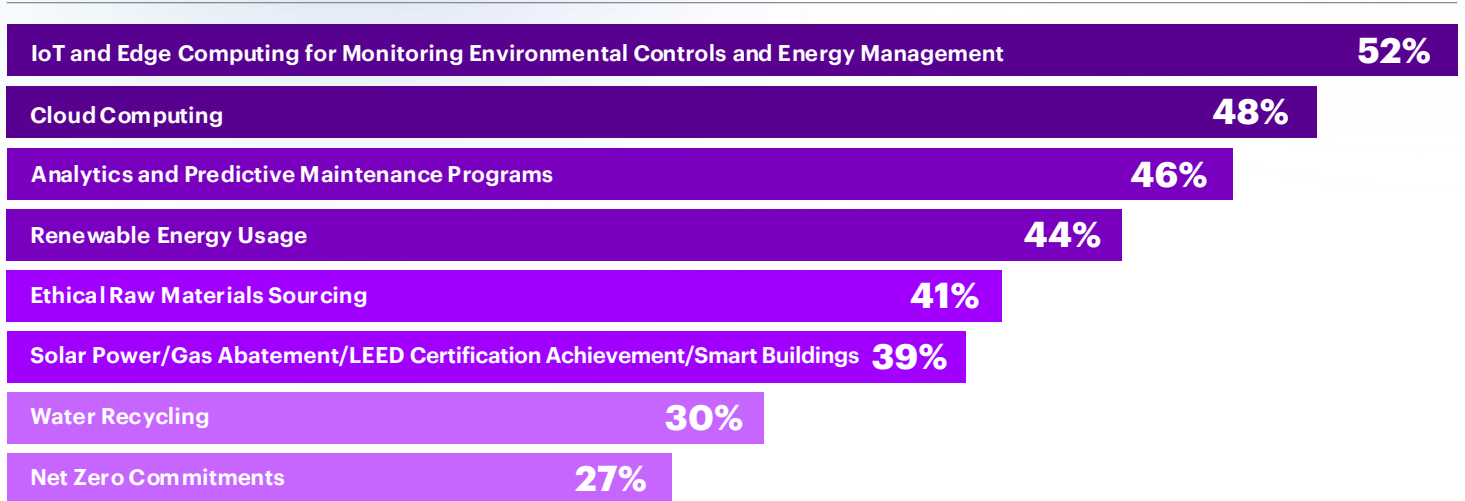


⁷ ["Department of Energy Announces Pledges from 21 Organizations to Increase the Energy Efficiency of Semiconductors and Bolster American Manufacturing,"](#) U.S. Department of Energy 09/21/2022

⁸ ["Scarcity Drives Fabs to Wastewater Recycling,"](#) IEEE Spectrum Online 01/25/2022

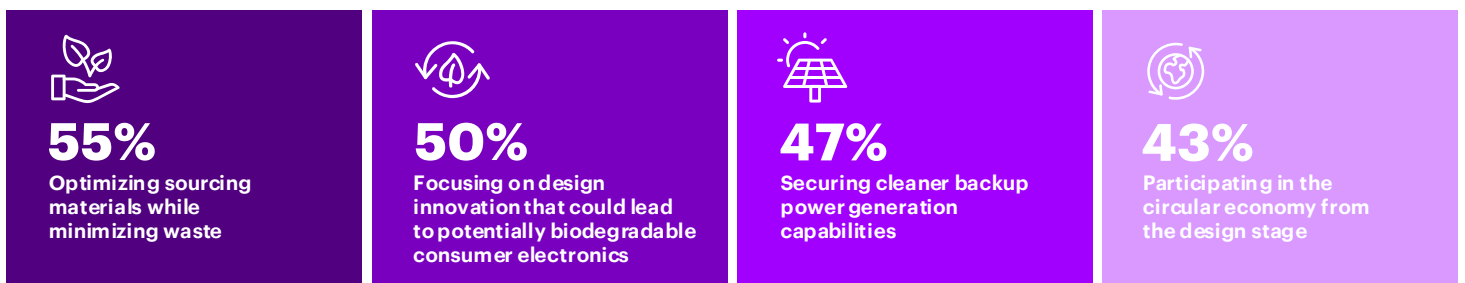
How can semiconductor companies get to a more-sustainable future? From a manufacturing perspective, companies have already embarked on various initiatives to create a more sustainable manufacturing process—led by deploying IoT and Edge computing to monitor energy consumption (Figure 7).

Figure 7: Initiatives semiconductor companies have enacted to enable a more sustainable manufacturing process



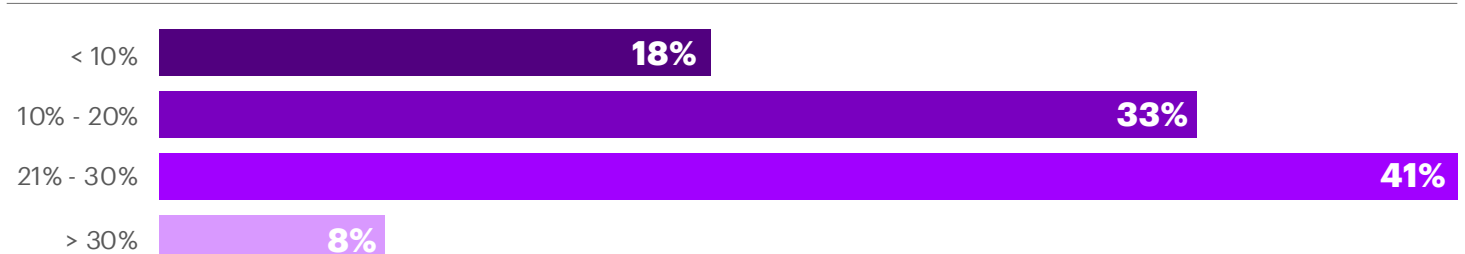
Beyond their internal facilities, semiconductor executives believe a number of actions could help drive more sustainable ecosystem outcomes (e.g., products, processes, and operations) (Figure 8).

Figure 8: Ways semiconductor companies could create more sustainable ecosystem outcomes



Optimizing sourcing while reducing waste was the top choice, but executives also believe paying closer attention to innovation at the design stage to create more circular (and, perhaps even biodegradable) products is key. Importantly, semiconductor companies are putting money behind such efforts (Figure 9).

Figure 9: Percentage of companies' budget (e.g. capex/opex) dedicated to sustainability programs



Our take

Bake sustainability into core manufacturing and process capabilities



Technology enables sustainable best practices, and semiconductors are at the core. It's a virtuous cycle, one in which semiconductor companies manufacture the chips that enable sustainability, which in turn helps semiconductor companies address or solve their own sustainability issues.

The challenge is making sure it truly improves the business—especially in manufacturing. For maximum, positive impact, sustainability initiatives in manufacturing and process capabilities must:



- **Plan well, execute, and measure with advanced analytics**
- **Include in corporate objectives, not just an “add on”**

Semiconductor companies need to work closely with each other on initiatives that can move the entire industry forward. A good example to start is the [Semiconductor Climate Consortium](#) to reduce greenhouse gas emissions across the semiconductor value chain⁹.

Sharing accumulated knowledge and innovative technology in this consortium can help companies accelerate their sustainability efforts and progress toward their climate goals. A logical first step is to implement and track sustainability programs, starting with digital tools supported by analytics. Then, supported by collaboration and information, sustainability becomes an industry imperative instead of remaining at the company level. Finally, innovation will continue to propel the industry forward—in its products and with a greener approach.

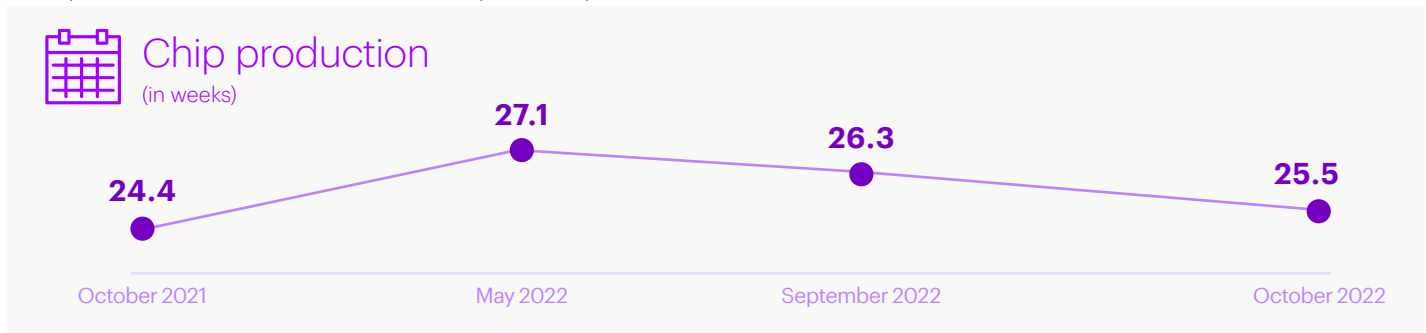
⁹ “[Semiconductor Climate Consortium](#),” Semi.org retrieved 11/2022



Mobility

The persistent chip shortage has disrupted the automotive and electronics industries, forcing some companies to scale back production. New vehicles can contain up to anywhere from 1,000 to 3,500 chips creating a downstream effect¹⁰.

There are signs the shortage is easing: October 2022's reported lead times were 25.5 weeks, compared with 26.3 weeks in September. The highest lead times of 27.1 weeks was in May, compared with the 24.4 week delay in the previous October¹¹.



As more and more digital technologies are integrated into autonomous vehicles, semiconductor companies need to be aware of trends in the space and the opportunities they create. For example, traditional modes of transportation are upended with drone delivery and air taxis already on the horizon. Autonomous vehicles aren't that far away.

42%

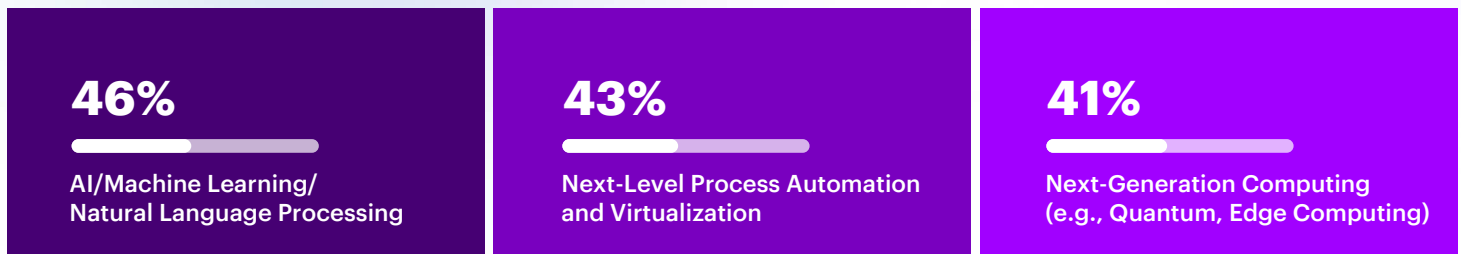
of executives believe some form of autonomous vehicles will become **mainstream for personal use** within just the next two years

¹⁰ ["Harnessing the Power of the Semiconductor Value Chain,"](#) Accenture 02/01/2022

¹¹ ["Chip Delivery Times Shrink in Sign That Supply Chain Is Easing,"](#) Bloomberg, 10/17/2022. Supplemental data provided by Susquehanna Research as of November 2022

Within three to five years, a large majority of executives expect autonomous vehicles to be common for local and long-haul trucking, and mass transportation. Innovation like this continues to be powered by several semiconductor-enabled technologies. The most prominent of these are AI, machine learning, and natural language processing (Figure 10).

Figure 10: Top 3 semiconductor-enabled technologies driving mobility innovation



At the same time, executives acknowledge that substantial roadblocks to scaling mobility products remain (Figure 11). The biggest of these, despite recent improvement, is a significant extension of the current chip shortage, followed closely by cost concerns.

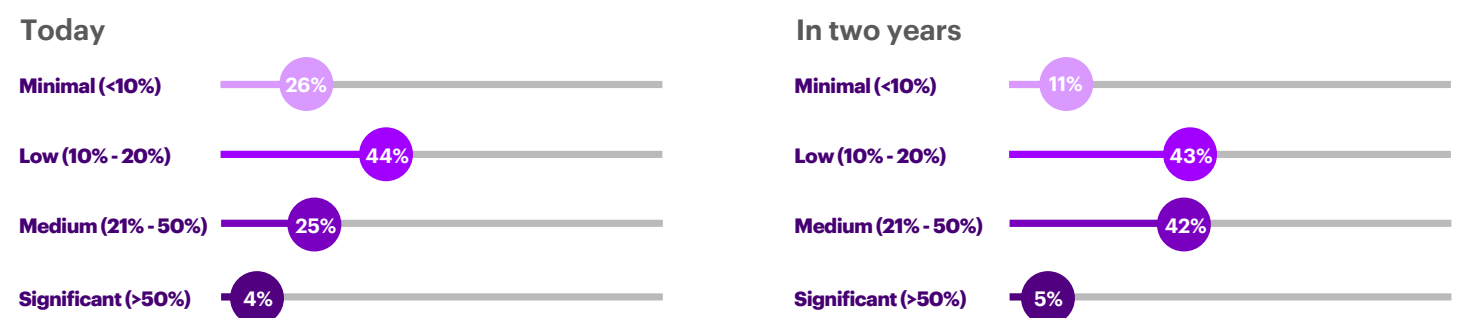
Figure 11: Substantial roadblocks to scaling mobility products, technological or otherwise



One way to overcome current obstacles is by establishing cross-industry partnerships. 93% of executives believe motor vehicle manufacturing companies should partner with technology companies to develop and ultimately deploy next-generation digital mobility technologies. The ideal partners for such a joint venture (JV), according to executives, are semiconductor design firms (31%) and integrated device manufacturers (25%).

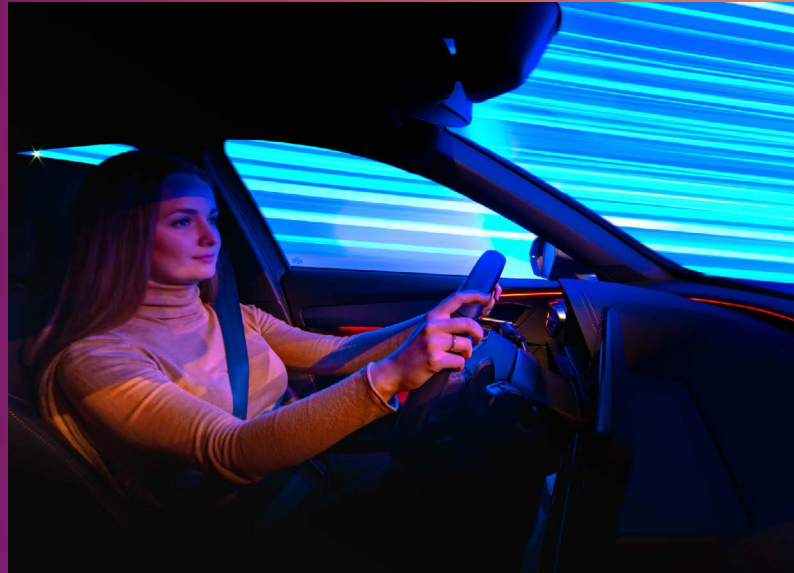
As is the case with the other focus areas in our study, mobility will gain more attention from semiconductor companies in the near future, with a growing portion of production dedicated to mobility-related products (Figure 12).

Figure 12: Allocation of semiconductor production to mobility



Our take

Competing with non-traditional and new market entrants



Unlike the metaverse and sustainability, semiconductor companies have a clear understanding of where to focus their time and efforts for the exact applications and use-cases of their chips. The struggle is balancing demand, supply chain challenges and design specifications for traditional, electric, and autonomous vehicles. At the same time, semiconductor companies need to forecast planning and address high-quality supply sourcing and manufacturing requirements.

Some companies could:



- **Create business functions separated by automotive and non-automotive**
- **Establish partnerships with existing clients and allocate/second engineering talent as needed**
- **Engage in M&A or JVs to develop in-house technologies that align with their market alignment goals**

Some automotive companies are forging ahead on their own. Recently, General Motors's autonomous driving unit said it will deploy its in-house designed chips by 2025, to decrease costs and increase volume. Tesla struck a JV with Swiss automotive semiconductor company, Annex, marking the first time an automotive company will be involved in the design and manufacturing of chips in China. Finally, Intel recently completed the IPO for Mobileye™, its autonomous driving business unit to unlock greater value for Intel shareholders and the company alike.^{12 13 14}

¹² ["Upset by High prices, GM's Cruise Develops its own Chips for Self-Driving Cars," Reuters 09/13/2022](#)

¹³ ["Can Chip Firms lead to Cutting-Edge Products Being Produced Domestically?," Asian News Network 12/07/2022](#)

¹⁴ ["Mobileye Pops More than 37% in Market Debut after Spinning out of Intel," CNBC 10/26/2022](#)

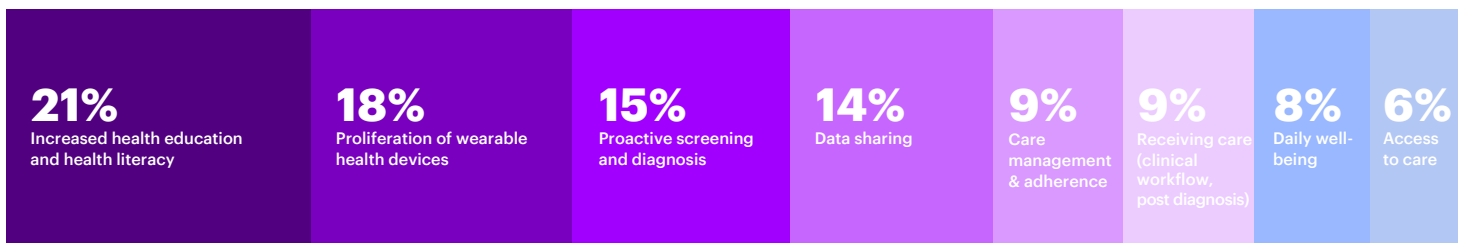


Digital health

Enterprises of all types are rolling out increasingly innovative digital health strategies. Whether the focus is developing electronic health records (cloud computing), creating data-driven recommendations (AI), or enabling telehealth offerings (devices and connections), leading organizations can fundamentally change both the way healthcare is delivered and the health consumer's experience.

In the current landscape, patients are actively demanding—and receiving—healthcare and health experiences consistent with daily life. As a result, the digital health agenda has become a priority for the C-suite to continuously unlock insights and expand products and services throughout the patient continuum. 89% of semiconductor executives agree that digital health innovations can increase the democratization of healthcare. Semiconductor innovation is responsible for the consumers greater health education and literacy, accessed by digital health products. (Figure 13).

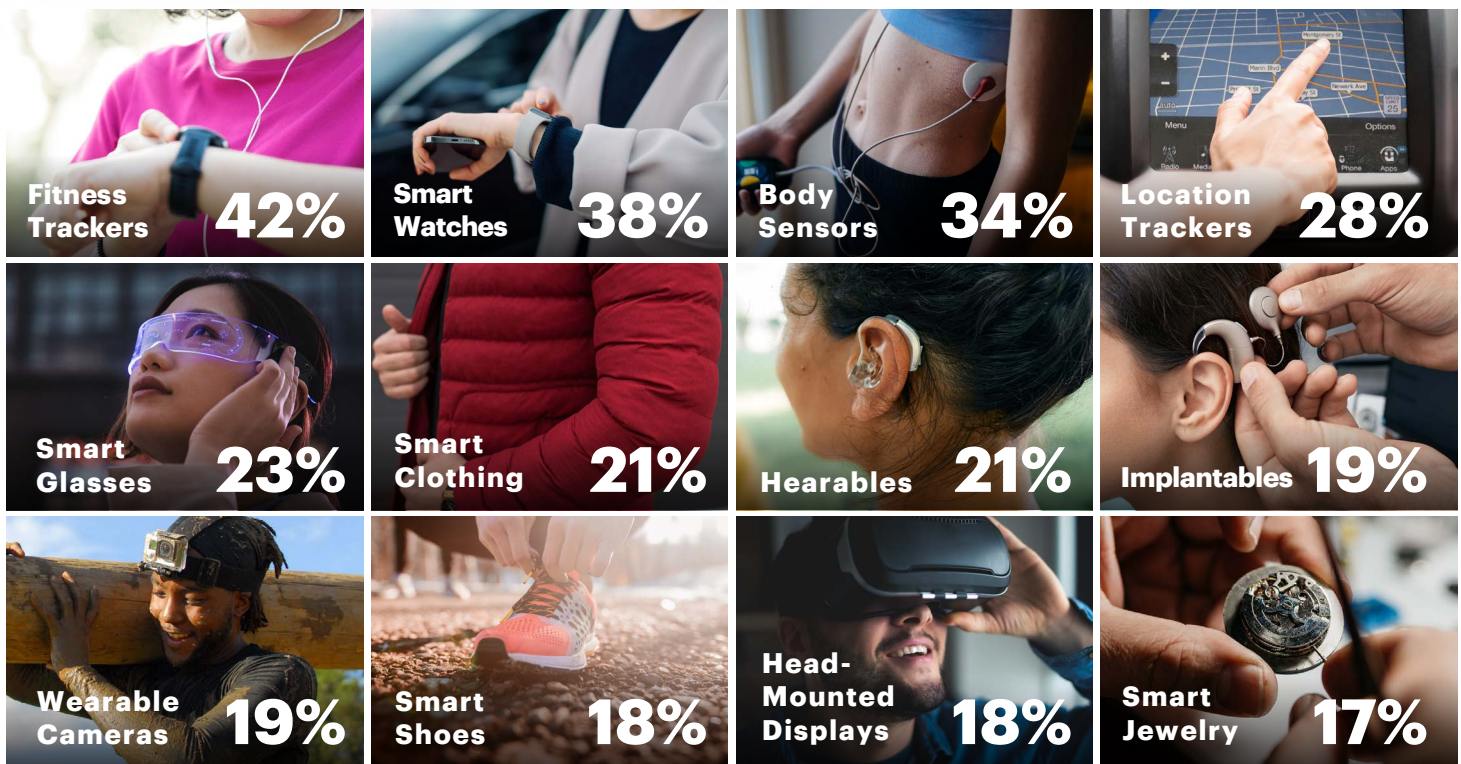
Figure 13: Semiconductor innovation enabling digital health products



Wearable devices, in particular, will become increasingly important and pervasive as people grow more proactive about monitoring and managing their health. In fact, 36% of executives think wearables are already having a significant impact on changing health for the better. 50% still believe more time is needed. Since wearables are on their way to improving health, respondents believe that they hope to see significant impact within the next five years.

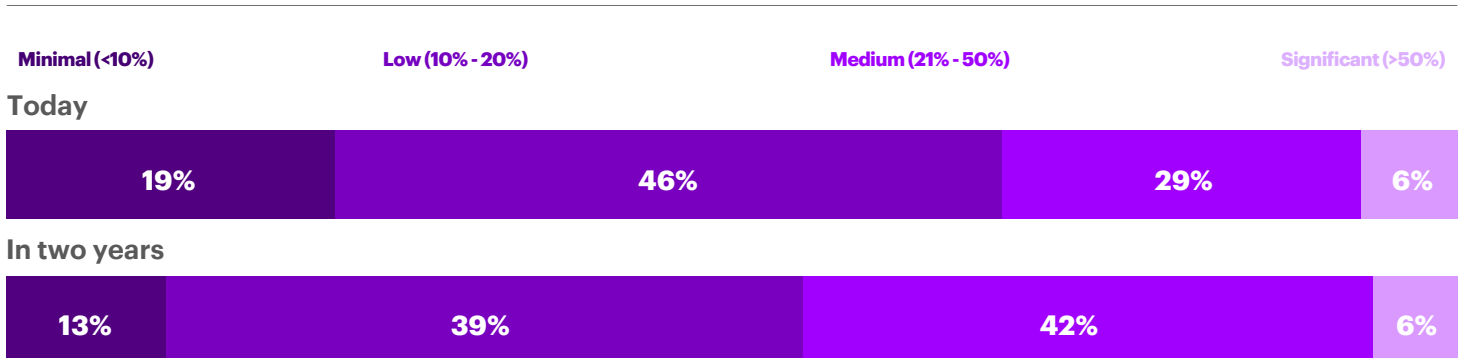
In the device space, widely available wearables—a growing part of the digital health ecosystem—have the most growth potential, according to executives in our survey (Figure 14). They include fitness trackers, wearables and body sensors. Interestingly, 71% believe select diagnostic imaging tools will eventually be digitized and commoditized enough to become wearable devices.

Figure 14: Wearable devices with the most growth potential



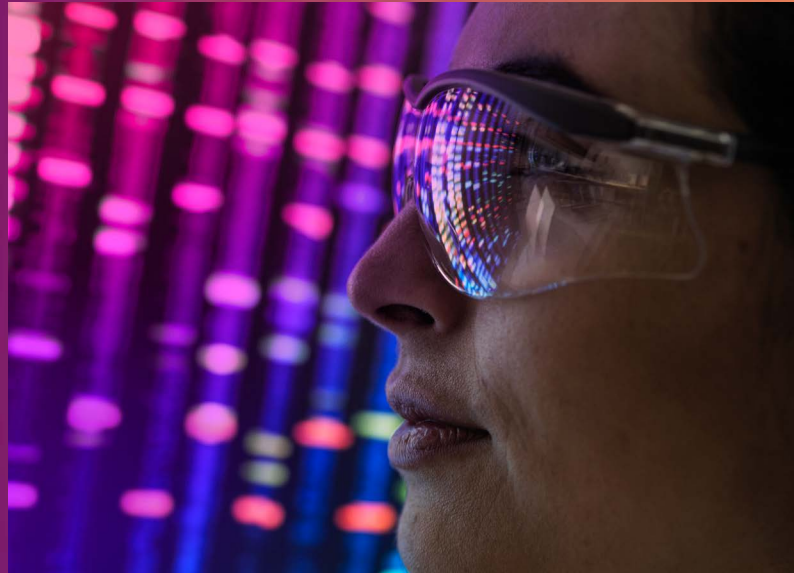
Recognizing the opportunities, semiconductor companies are ramping up investments to serve the digital health market, with a growing portion of their production earmarked for such applications (Figure 15).

Figure 15: Allocation of production to digital health



Our take

Focus on specific applications, not broad-based technology



Current digital health trends, much like those in the metaverse, share a common theme: application. Semiconductor companies traditionally think about their technology from a capabilities standpoint in terms of modems, connectivity, and speed. As digital health evolves from devices to applications, chip makers must consider outcomes and usage to deliver on the technology's promise. Much like enabling the metaverse, companies should consider today's demand with tomorrow's promise—in terms of economics, capacity, and outcomes. For example, researchers at the University of Chicago's Pritzker School of Molecular Engineering developed a chip that could collect data from multiple biosensors and draw conclusions about a person's health using cutting-edge machine learning. The chip needed to be flexible enough to wear on the user's skin and provide additional processing power to collect the data.¹⁵

To stay ahead of these developments, R&D in this area should consider technological advancements, the growing use of connected devices, and the explosion in the digitization of manual processes and operations in the healthcare industry:



- **Dedicate more investment to wireless technology and sensors that enable connected devices**
- **Partner with application companies that offer solutions for harnessing data from connected devices**

Developing technology for very specific applications is different from broad-reaching capabilities. Semiconductor companies should determine where and how they want to play—as a creator or an ecosystem provider.

¹⁵ "Stretchy Computing Device Feels like Skin—but Analyzes Health Data with Brain-Mimicking Artificial Intelligence," The University of Chicago News 08/04/2022

The need for transformative change

The wide-ranging, significant challenges semiconductor companies face today drive the need for companies to break away from business as usual. The strategies and operations that served them well in the past need to be recalibrated to foster greater resilience and sustain innovation. It's part of a journey we refer to as "Total Enterprise Reinvention" (TER). TER is one of Accenture's Five Forces, the trends shaping the future of business that companies that wish to be leaders in the next decade must harness.

TER for the semiconductor industry includes transforming the ecosystem and value chain with an intelligent digital core enabled by cloud, AI, and analytics; investing in automation and digital tools; and sourcing new partners to drive technology and operations innovation.¹⁶

In the near term, TER's cloud-based analytics and AI tools can dramatically improve decision making across a company's operations—from understanding demand patterns and being able to forecast when demand could lead to a chip shortage; to gaining deep visibility on the shop floor that can help boost yield; to talent recruitment and retention efforts; and to investing in R&D to create new and compelling offerings across future technologies. In the medium-term, TER's results expand into creating new business operations to accelerate growth by delivering on product enhancements in the four areas we explored in the metaverse, sustainability, mobility, and digital health.

Key actions

Accelerate the adoption of AI, cloud, and analytics beyond core chip business to manufacturing processes

Ramp up investments to build-in automation and digital tooling from the start

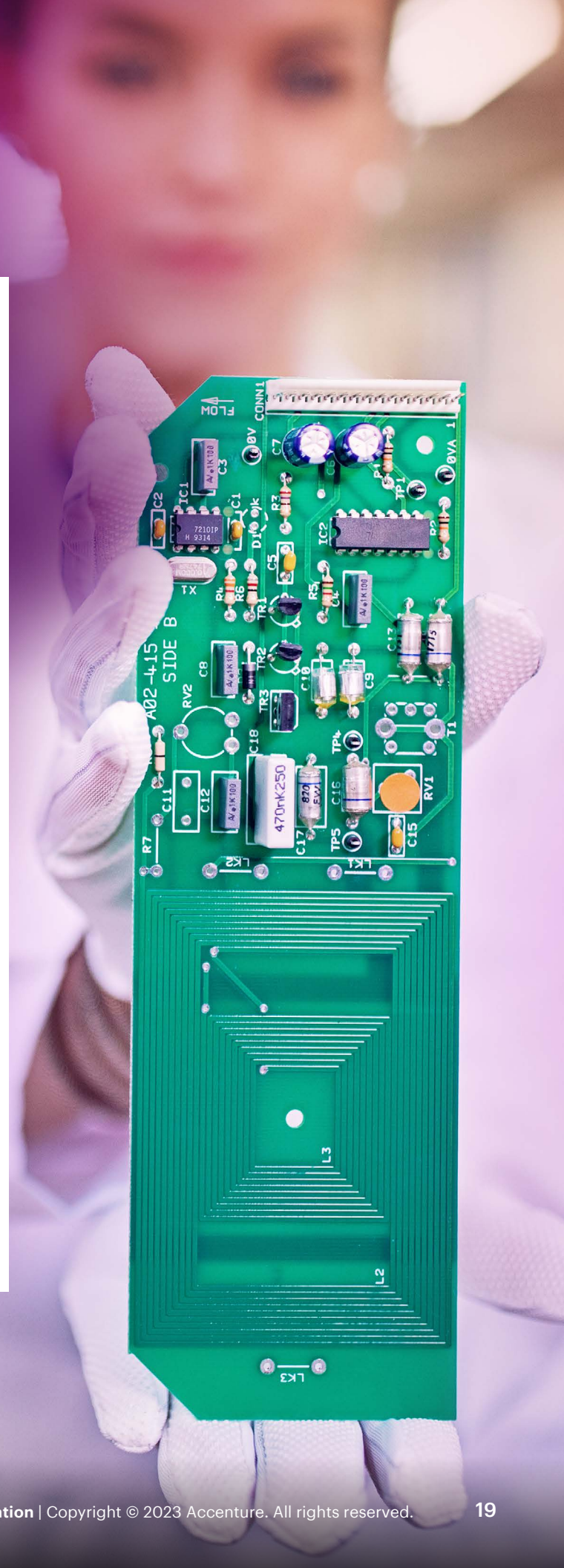
Discover a new network of incentives and partners that can help address gaps in technology and operational portfolio

¹⁶ "2022 Investor & Analyst Conference," Accenture 04/07/2022

Conclusion

The semiconductor industry faces many challenges, some of those unlike any experienced before. But they're not insurmountable.

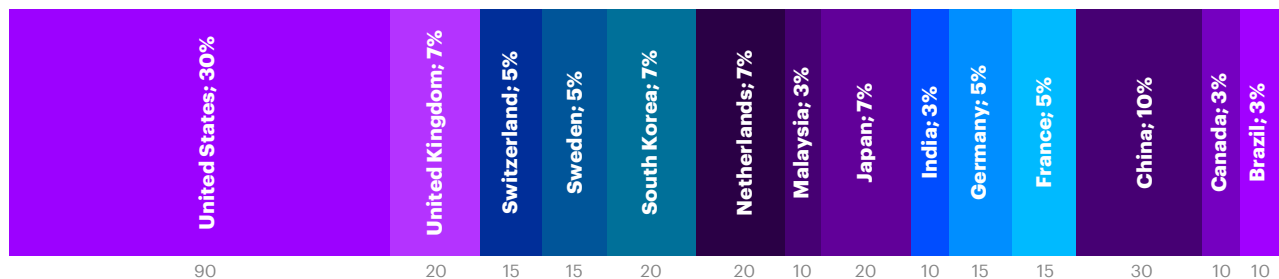
The executives in our research are bullish on their companies' ability to develop the resiliency needed to tackle these obstacles head on, capitalize on the new opportunities, and continue its unbroken streak of innovation. After all, if almost 2 out of 3 (65%) of executives believe that Moore's Law will slow down by 2025, the time to start is today.



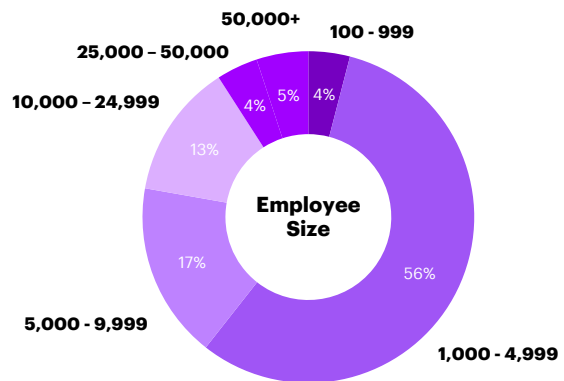
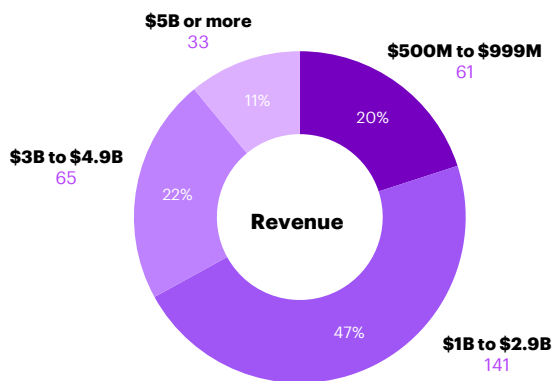
About the research

In late 2022, Accenture surveyed 300 global semiconductor executives, 57% of whom are C-level leaders and 33% are at the executive vice president or vice president level.

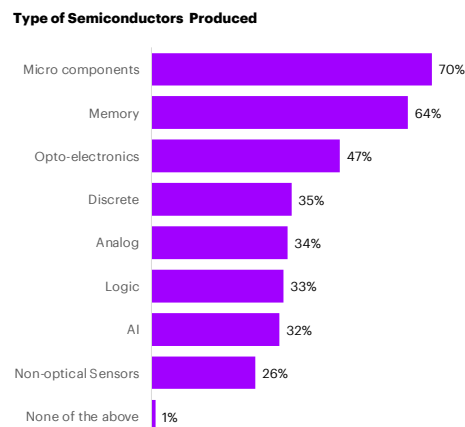
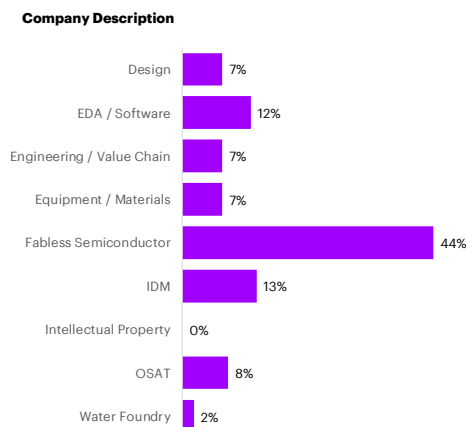
Participating companies represent 14 countries...



...a wide range of sizes...



...and different parts of the semiconductor value chain.



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