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SIEMENS DIGITAL INDUSTRIES

In today's rapidly evolving semiconductor ecosystem, sustainability matters

Major trends now impacting semiconductor lifecycles

It's a time of intense change across the global semiconductor ecosystem, which faces a rapid evolution with every stage of semiconductor lifecycles being impacted by major trends. As a result, the need for smart manufacturing for semiconductors and end-to-end lifecycle management (LMS) is critical.

I. Sustainability

Compliance and sustainability management demand data integrity for secure traceability of semiconductor devices from silicon to system.

The situation

- **Why is sustainability so important?** As the semiconductor industry rapidly expands, with projections for chip production nearly doubling by 2030[1], there is a looming environmental challenge. Most semiconductor plants operate continuously, 24/7, resulting in a significant environmental impact, from high energy consumption to the emission of greenhouse gases and hazardous pollutants.

- Sustainability and compliance are ever-increasing challenges to an industry facing critical product shortages, supply chain uncertainty, security concerns, stringent regulations, traceability and quality issues, and shortages of sustainable materials. On top of that, there is the urgency to reduce the carbon footprint, minimize water and energy usage, lower chemical usage, provide safer handling of hazardous materials and when needed, to guide material extraction. No easy task.
- Compliance remains challenging in a time when Siemens experts estimate that 10% of components that reach an electronics manufacturing service line today are compromised, whether they be counterfeit, refurbished, or damaged, making secure end-to-end traceability essential.
- In today's ecosystem, sustainability and compliance demand secure end-to-end traceability and digitalization of all semiconductor devices and data, for IP and metadata, to provide a digital footprint of integrated circuits, to verify raw materials and compliant sourcing, and to trace sustainability metrics.

Siemens joins Semiconductor Climate Consortium (SCC)

In partnership with the SCC and member companies, we will strive to reduce our global footprint and improve semiconductor manufacturing resilience.

Count us in!

Traceability matters

Secure end-to-end traceability and digitalization is a must-have if we are to track, trace and identify the **10% of semiconductor components which are compromised before installation.**

The Siemens solution

This complex challenge can only be met with design and manufacturing agility and responsiveness to remain innovative in meeting market demands by becoming a Digital Enterprise (DE), which offers chipmakers the complete journey to digital transformation. With Siemens Xcelerator, the industry can accelerate the digital transformation of semiconductor processes to scale up for adaptive, people-centric, and sustainable production to optimize quality and efficiency for faster, fully traceable chip production, while minimizing their carbon footprint.

II. Secure digital transformations

Today's volatile ecosystem demands unified data management for secure IP and collaboration plus real-time visibility of business processes needed for quality assurance.

The situation

- IP is the secret sauce behind the creation of software, smartphones, and a wealth of new products: a recent government report estimated that IP-intensive industries accounted for 44% of all U.S. employment.[2]
- The FBI estimates that intellectual property (IP) theft costs the U.S. economy between $225 billion and $600 billion annually.[3]
- The semiconductor industry is the most targeted by cybercriminals, with 39% of surveyed organizations experiencing a breach in 2018, according to a study by Gartner.[4]
- Guarding IP security is critically important in today's ecosystem as it is estimated that trade secrets can comprise up to 80 percent of a semiconductor company's IP portfolio.[5]
- 1 in 5 U.S. companies have suffered IP theft, resulting in losses of over $600 billion.[6]

The Siemens solution

One end-to-end digital solution for semiconductor lifecycle management provides enterprise-wide intellectual property (IP) data management for internal and 3rd party IP, design flows and reuse to ensure security, quality and productivity.

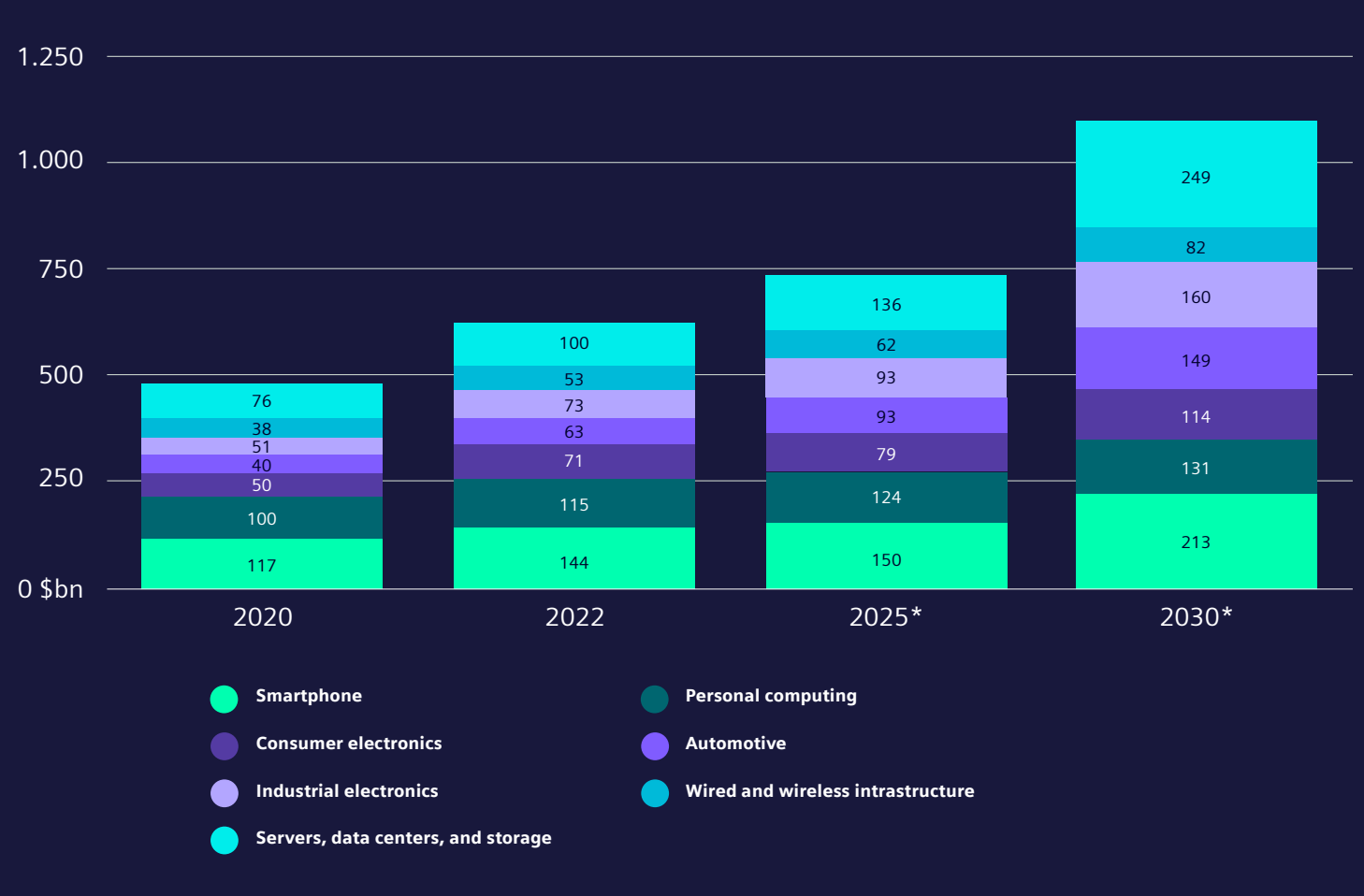
III. Emerging technologies

Rapid ecosystem evolution, emerging technologies and rising product complexity are impacting every semiconductor lifecycle stage.

The situation

With rising chip demand, emerging technologies and surging product complexity, the global semiconductor ecosystem is poised to become a trillion-dollar industry by 2030.[7]

Increasingly complex products are driving global semiconductor market revenue growth from 2020 to 2030 when it is forecasted to exceed $1 Trillion.

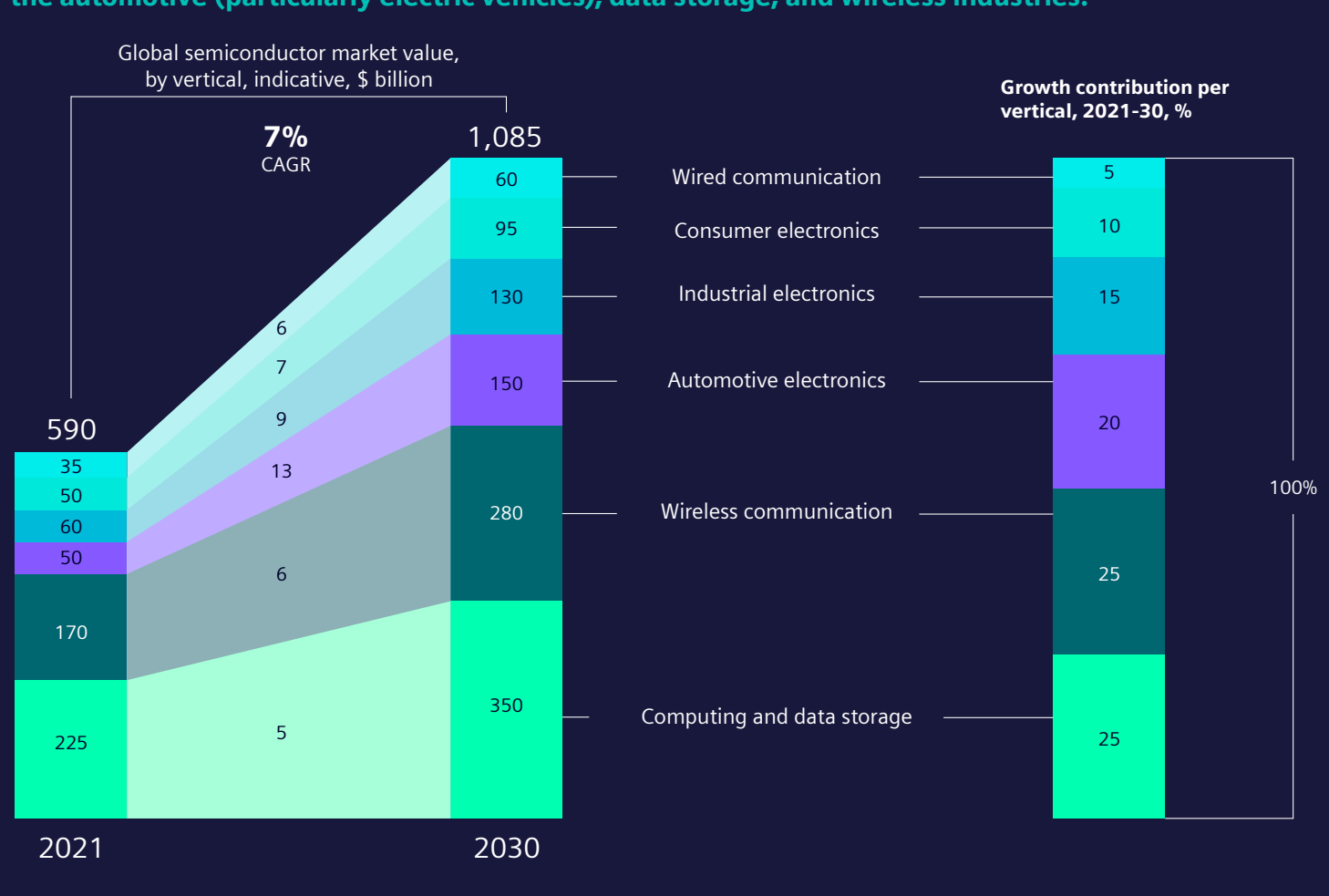


1.250
1.000
750
500
250
0 $bn
2020: 117, 100, 50, 40, 51, 38, 76
2022: 144, 115, 71, 63, 73, 53, 100
2025*: 150, 124, 79, 93, 93, 62, 136
2030*: 213, 131, 114, 149, 160, 82, 249
Smartphone
Personal computing
Consumer electronics
Automotive
Industrial electronics
Wired and wireless intrastructure
Servers, data centers, and storage

Source: ASML ANNUAL REPORT 2022[8]

*ASML's Investor Day presentation (November 2022)

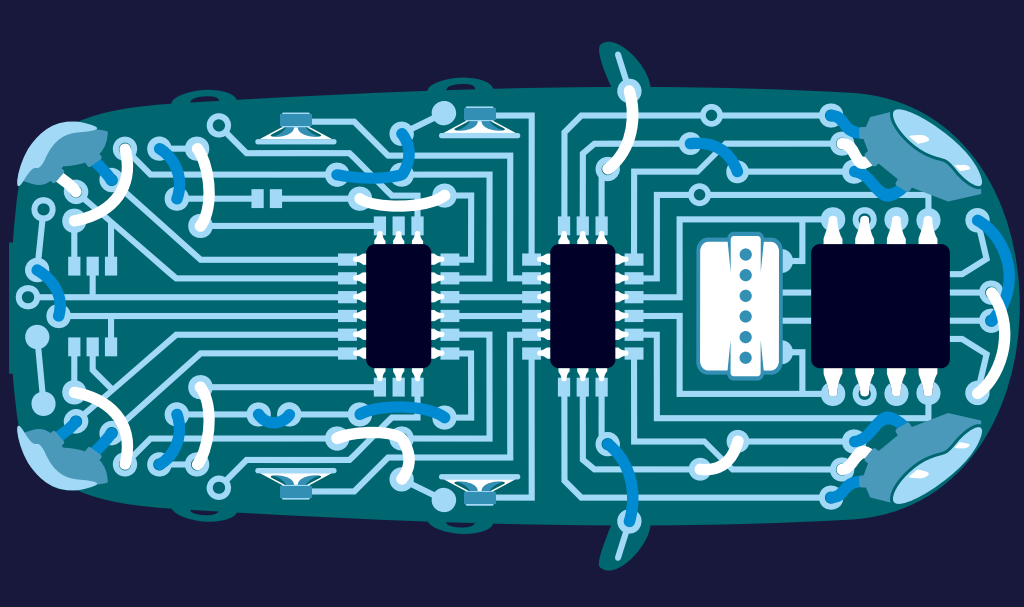
The lion's share of semiconductor growth, about 70 percent, is predicted to be driven by the automotive (particularly electric vehicles), data storage, and wireless industries.[9]



Global semiconductor market value, by vertical, indicative, $ billion
7% CAGR
590
2021: 225, 170, 50, 60, 50, 35
1,085
2030: 350, 280, 150, 130, 95, 60
5, 6, 13, 9, 7, 6
Wired communication
Consumer electronics
Industrial electronics
Automotive electronics
Wireless communication
Computing and data storage
Growth contribution per vertical, 2021-30, %
5, 10, 15, 20, 25, 25
100%

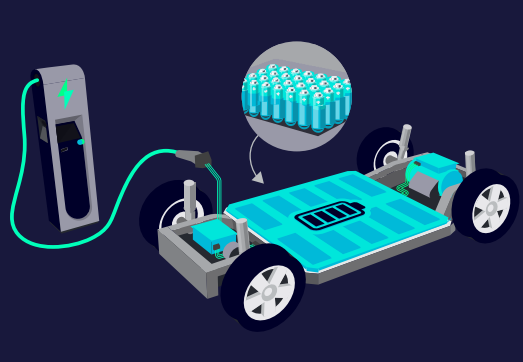
Source: McKinsey[9]

Semiconductors are also enabling the emerging technologies that will drive the future economy and national security — AI, 5G/6G, quantum computing, cloud services, and more.[10]



INCREASING PRODUCT COMPLEXITY Semiconductors in an ICE Vehicle vs. a BEV

Internal Combustion Engine vehicle
1,000 microchips (est.)



Battery-electric vehicle (BEV)
2,000 microchips (est.)[11]

According to Management Consultancy P3[12], most additional auto semiconductors will be in the complex powertrain.

> "With the continued focus on electric and autonomous vehicles, the auto market has the highest forecast growth of 12.4% by 2026. This is a prime example of an industry requiring increasingly sophisticated technology making it challenging for semiconductor companies to race to fulfill orders for new application-specific chips for the auto industry."

Source: Accenture[13]

The Siemens solution

For a diverse range of complex technologies, semiconductor companies can develop and deliver innovative devices with highest level of initial quality for faster NPIs via a single collaborative platform for quality management systems (QMS) and LMS solutions.

IV. Globalization

Supply chain volatility drives the need for secure collaboration across the semiconductor ecosystem supported by strong supplier management.

The situation

- In today's global supply chain, components for a single chip can travel 25,000 miles (about 40233.6 km) to numerous specialized collaborators before they are ready for installation, according to research from the Global Semiconductor Alliance and Accenture.
- 75% of global semiconductor manufacturing capacity is currently located in East Asia.[14]
- Europe's share in global chip manufacturing has dropped from 25% in 2000 to 8% today, according to consulting firm Kearney.[15]
- The U.S. share of modern global semiconductor manufacturing capacity has declined from 37% in 1990 to only 12% today.[16]
- For many semiconductor companies, secure collaboration across the ecosystem is hindered due to fragmented systems, many of which lack a common data platform or common language, as over 60% of semiconductor companies currently use six or more different systems to manage their data.[17]
- Despite security challenges, collaboration is still essential and is increasing at big semiconductor companies.[18]

It takes a global village

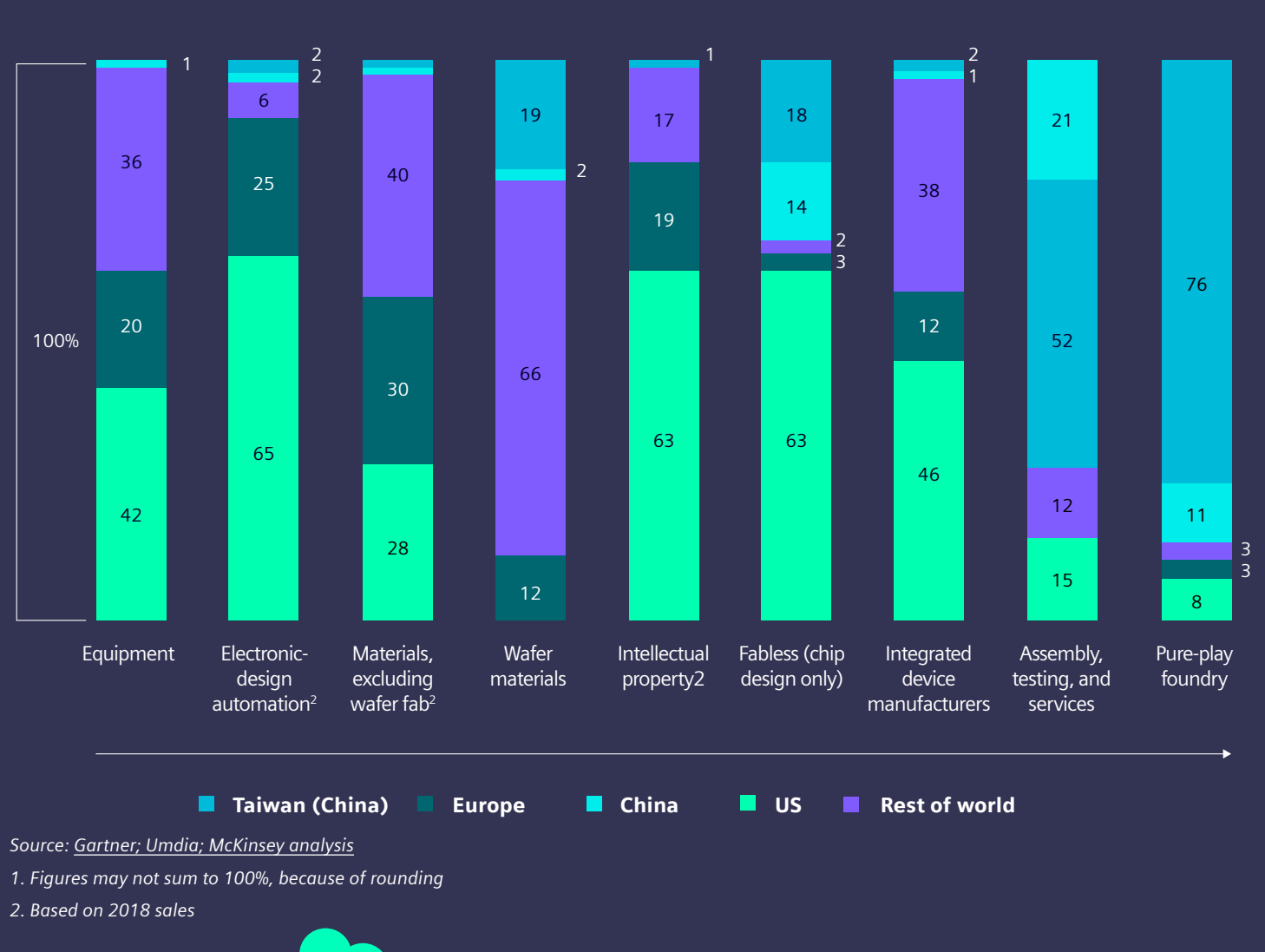
This graphic example lists the countries and regions and some of the capabilities they contribute to the semiconductor value chain ecosystem.[19]

US - OEMs lock in chip design for end products
UK - Semiconductor IP houses license IP blocks to fabless firms
China – EMS players integrate ICs into OEM end product electronics
US - Fabless firms design complex chips with the support of EDA software
Netherlands – Fab Capital Equipment make the process equipment used by fabs to manufacture chips
Japan – Materials companies form silicon ingots from pure silicon and slice into wafers
US – Test equipment firms design and manufacture equipment used by OSATs to test semiconductor chips
Germany – Gases, specialty chemicals and fab consumable suppliers equip fabs with key fabrication and facility cleaning materials
India - Design verification teams verify specifications and layout
Taiwan (China) – Foundries etch 60+ layers of transistors and interconnected wires onto wafer to develop integrated circuit (IC)
Argentina – Consumer buys smartphone
Malaysia – OSATs assemble, package, and test semiconductor chips

It takes global capabilities[20]

No local market or company has all the capabilities required for end-to-end semiconductor design and manufacturing.

2020 semiconductor sales along the value chain[1], % share

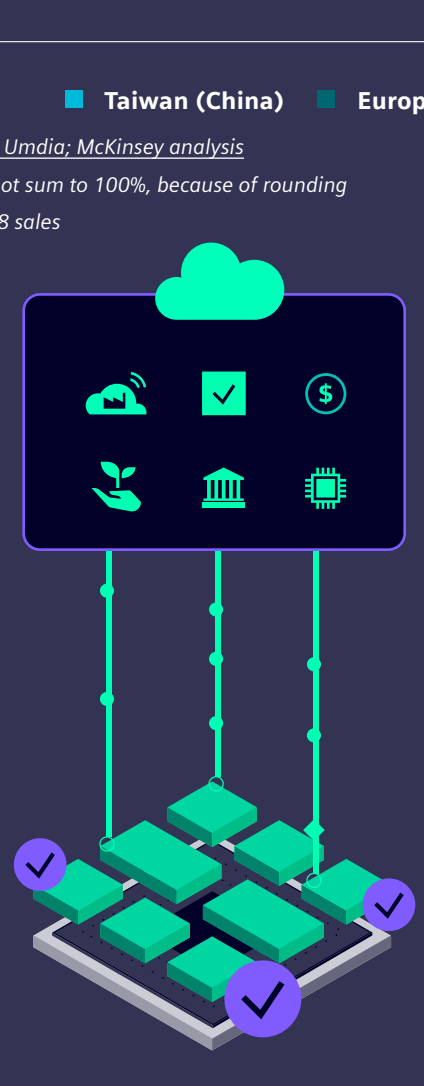


100%
Equipment: 42, 20, 36, 1
Electronic-design automation²: 65, 25, 6, 2, 2
Materials, excluding wafer fab²: 28, 30, 40
Wafer materials: 12, 66, 2, 19
Intellectual property2: 63, 19, 17, 1
Fabless (chip design only): 63, 3, 2, 14, 18
Integrated device manufacturers: 46, 12, 38, 1, 2
Assembly, testing, and services: 15, 12, 52, 21
Pure-play foundry: 8, 3, 3, 11, 76
Taiwan (China)
Europe
China
US
Rest of world

Source: Gartner; Umdia; McKinsey analysis

1. Figures may not sum to 100%, because of rounding

2. Based on 2018 sales



Why does it matter if every lifecycle stage is connected?

All product information and design data (customer requirements, original technical specifications, design definitions, production schedules, analysis results, sourcing plans, and quality inspections) are included and tied to critical processes and tasks from requirements to final delivered chip, making it much easier to trace defects, provide verification, and resolve any issues.

The Siemens solution

This complex challenge can only be met with design and manufacturing agility and responsiveness to remain innovative in meeting market demands by becoming a Digital Enterprise (DE). With Siemens Xcelerator, the industry can accelerate the digital transformation of semiconductor processes to scale up for adaptive, people-centric, and sustainable production to optimize quality and efficiency for faster, fully traceable chip production, while minimizing their carbon footprint.

What's next?

What if your semiconductor company could advance sustainable chip design and production processes to scale up with smart, secure operations throughout the product lifecycle while minimizing your environmental impact?

Learn more

For more information, visit: siemens.com/l-m-semi

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