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Forging Germany's digital destiny

The imperative of a sustainable microelectronics strategy

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EXECUTIVE SUMMARY

Microelectronics has an exponentially growing importance for national economies and is crucial for digital sovereignty. Yet, Europe and Germany lack a significant global footprint in this sector. Thus, the continent needs to develop and implement a sustainable strategy to restore its own digital sovereignty. In this report, such a potential strategy for Germany is presented.

Currently, Europe and Germany are highly dependent on Asia and the US. The share of US companies in overall microelectronics design is around 80%, with design being a major value contributor to the entire value chain. 75% of all silicon wafers, the base material for nearly all microelectronics, is manufactured in just four Asian countries: Taiwan, South Korea, Japan, and Mainland China (hereinafter referred to as China). The same countries control a similar share of microelectronics front-end production. For memory chips, present in nearly all electronic devices, the production share for these countries is even higher, at 93%.

To reduce these dependencies and secure digital sovereignty, countries around the world have set up comprehensive, multi-billion-dollar funding programs, including the EU and Germany. A comprehensive and holistic microelectronics strategy is required to guide these efforts and ensure sustainable impact. This report presents such a potential strategy for Germany, consisting of four coherent strategic programs:

1. The first and largest program aims to establish a chip design ecosystem to foster innovation in Europe. It is centered on a chip design campus where different players across the microelectronics value chain come together and collaborate.

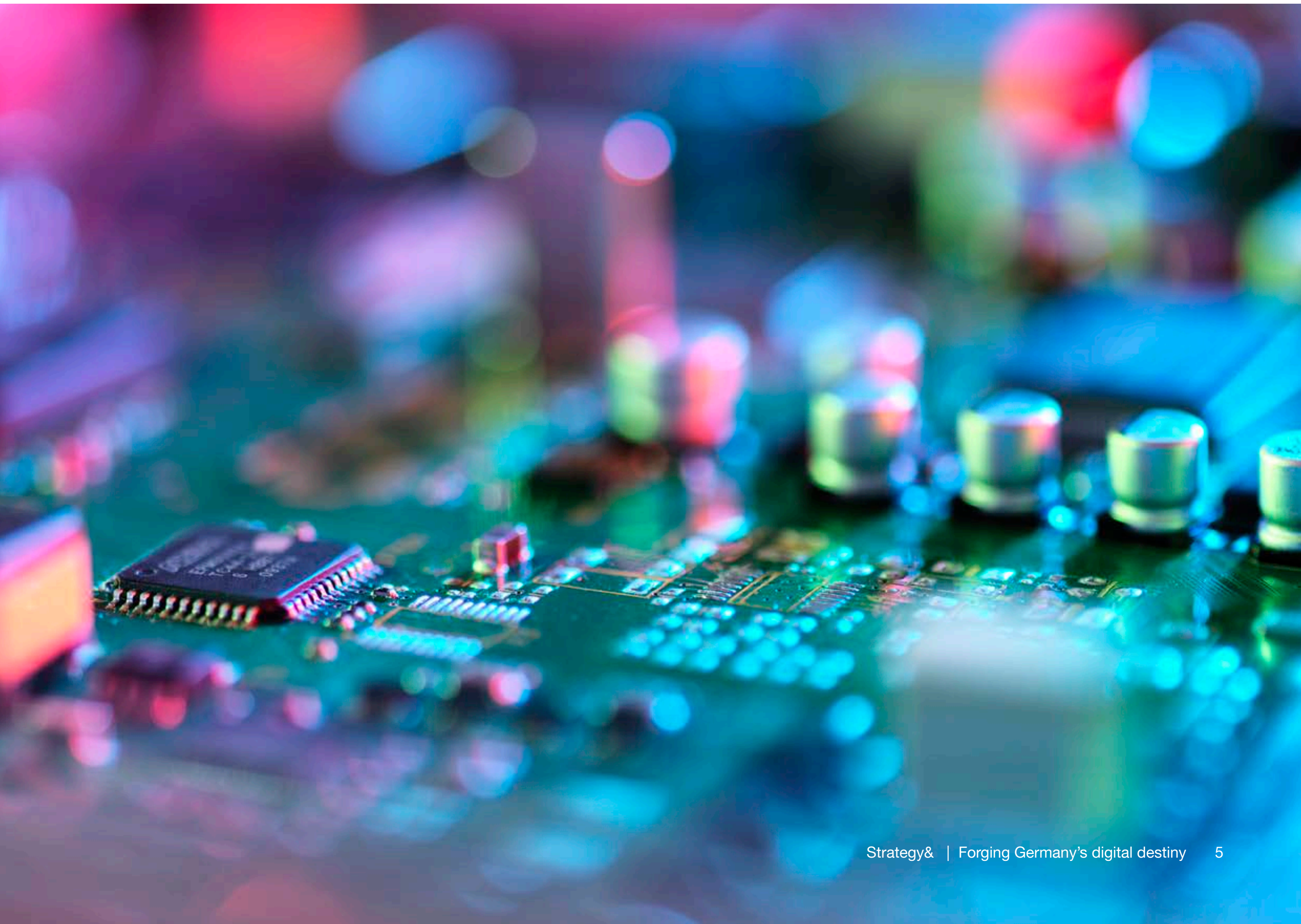
2. The second program strengthens and expands the existing European microelectronics landscape with a focus on wafer production and medium nodes, required e.g., for power electronics, sensors, optoelectronics, and safety microcontrollers.

3. The third program ensures a favorable and sustainable environment for the industry to flourish.

4. The fourth program covers further important fields for expansion, namely memory chips and photovoltaic cells.

While the report mainly focuses on Germany, similar topics need to be considered in the European context.

To implement this strategy and secure Germany's digital sovereignty, roughly € 115 billion of public and private investment is required over 10 years. More than half of this will be needed for production sites for smallest nodes, the most advanced microelectronics technology currently available. Considering all synergy effects, the positive impact on the global macroeconomic situation is estimated to reach over € 3 trillion in 2035, comparable to the current GDP of the UK or India. The positive impact on Germany's GDP alone can be up to € 600 billion. The government has to provide the right basic conditions, as well as funding, support, and direction, but industry has to align and take ownership of the strategy implementation. Measures such as the chip design campus depend on active participation by industry players. It is time to join forces and secure Germany's digital sovereignty.



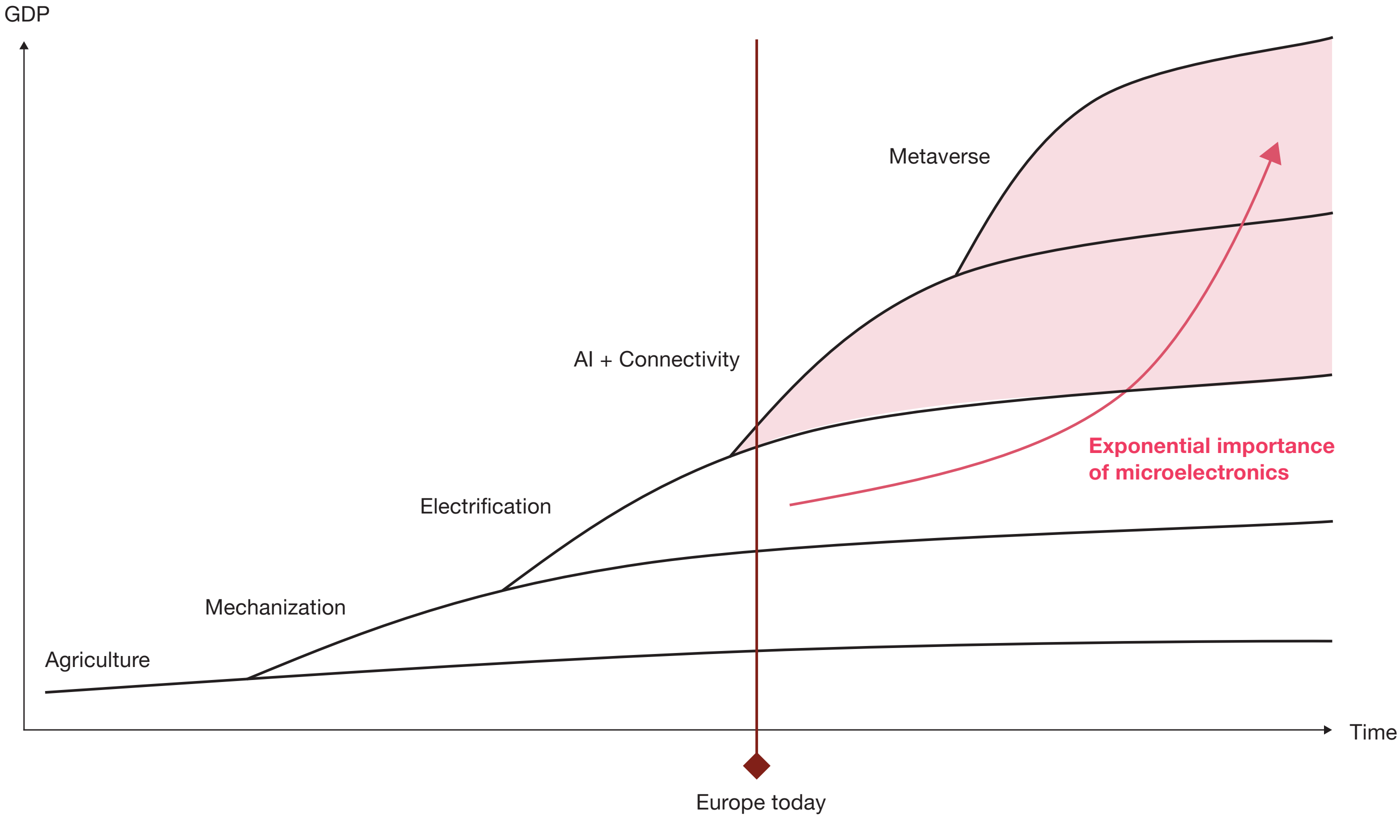
SECTION 1

1. Introduction

In an increasingly interconnected and technology-driven world, the importance of microelectronics as a foundational pillar of innovation cannot be overstated. Megatrends such as artificial intelligence (AI) or the metaverse will lead to sizable growth in a nation's gross domestic product (GDP), as *Exhibit 1* indicates. These megatrends, as well as critical infrastructures such as power plants or telecommunications networks, are heavily dependent on microelectronics. At the same time, the global chip shortage that started in 2020 showed clearly how fragile the industry's globalized supply chains are. The increasingly tense geopolitical situation added an additional layer of uncertainty.

EXHIBIT 1

Development stages of human economy and their impact on a nation's GDP



Source: Strategy& analysis

> There is no digital without chips. […] Europe's share across the entire value chain, from design to manufacturing capacity has shrunk. We depend on state-of-the-art chips manufactured in Asia. So this is not just a matter of our competitiveness. This is also a matter of tech sovereignty. So let's put all of our focus on it."
>
> **Ursula von der Leyen,**
> **President of the European Commission**

Taking in particular resilience, competitiveness, and national security aspects into account, it becomes clear that microelectronics will be crucial for a nation's digital sovereignty. This term refers to a nation's ability to independently control, develop, and utilize its own digital infrastructure, services, technologies, and economic policy, ensuring autonomy, data privacy, and security, without relying on foreign entities or technologies. It involves fostering domestic innovation and research to reduce dependence on external influences, thereby safeguarding interests in the digital era. Increasing digitization is leading to the creation of digital twins of individuals, companies, and even whole nations. Without digital sovereignty, they are exposed to a very high risk of external influence. The consequences can be dramatic, from altered consumer behavior to manipulated elections.

As a result, countries around the world have acknowledged the importance of microelectronics to secure their digital sovereignty. Regulatory actions have been put into place to protect critical infrastructure from external influences, such as the ban on 5G telecommunications components from Chinese manufacturers in the US and numerous European countries. On top of this, comprehensive funding programs have been started to assist with the enormous investments required and to increase supply chain resilience. Prominent examples are the CHIPS for America Act in the United States, worth over US$ 52 billion, the China Integrated Circuit Industry Investment Fund (known as the "Big Fund"), with its third phase worth around US$ 41 billion, and the EU's European Chips Act, with over US$ 19 billion of public funding (*see Exhibit 2, next page*).

The EU also proclaimed its ambition to reach a 20% share of global microelectronics production in 2030, starting from 9% in 2021. When comparing the GDPs of countries with relevant microelectronics industry, Europe could even set its ambition higher, for a global share of 28%.

28%

share of global microelectronics production would be an appropriate ambition for the EU, when comparing the GDPs of countries with relevant microelectronics industry. Currently, it is set at 20%.

At the same time, the microelectronics supply chain is highly globalized. When also taking financial and human capital limitations into account, it is clear that neither Germany nor the EU will reach full self-sufficiency in the microelectronics sector. This would also not be desirable, as inefficient and expensive structures would result, ultimately inhibiting further development and innovation. Instead, collaborations and partnerships between countries with similar value systems will become pivotal in producing critical microelectronics. Like defending a nation's sovereignty, e.g., NATO allies would equally be ideal partners to jointly safeguard their digital sovereignty.

EXHIBIT 2

Overview on public funding initiatives in selected countries

USA	EU	China	South Korea	Japan	Taiwan
CHIPS for America Act	**European Chips Act and IPCEI**	**Big Fund III**	**Microelectronics Cluster**	**Investment Fund Microelectr. industry**	**Taiwan Chips Act**
					
$52 bn by 2026	**>$19 bn** by 2030	**$41 bn**[1] by 2028	**~$3 bn**[2] by 2032	**$6.8 bn** by 2026	**Tax Incentives** until 2029
Domestic production, R&D	Domestic production, R&D	Aiming for self-sufficiency in microelectronics	Creating an environment for private investments	Production, cutting-edge technologies and jobs	Production, R&D, attracting foreign investment

1 Exact amount of phase three not officially announced yet, actual value might still change. Part of it comes directly from the central government budget, another part from state-owned enterprises. The amount does not include further subsidies planned on provincial and district levels. In total, funding worth >$100 billion is expected
2 The amount includes public direct investments and a small part of joint investments with the private sector
Source: Strategy& analysis

To maintain a strategic position and strong negotiating power in the global microelectronics market, it is also crucial to establish certain control points within the value chain and defend them against disruptions. One option is to possess a significant technological advantage, such as ASML's extreme ultraviolet (EUV) lithography in Europe, which facilitates the fabrication of microelectronics with the smallest node sizes. Another option is to control a substantial share of global production capacity, like the strong dominance of China for photovoltaic cells.

Germany and Europe have to clearly position themselves in the global context and invest strategically to achieve and maintain digital sovereignty, without striving for full self-sufficiency. A comprehensive and holistic microelectronics strategy is required on a national and pan-European level. For this, the complete global microelectronics landscape must be investigated and analyzed to identify critical topics, potential gaps, and control points, as well as fields of innovation that should be prioritized.

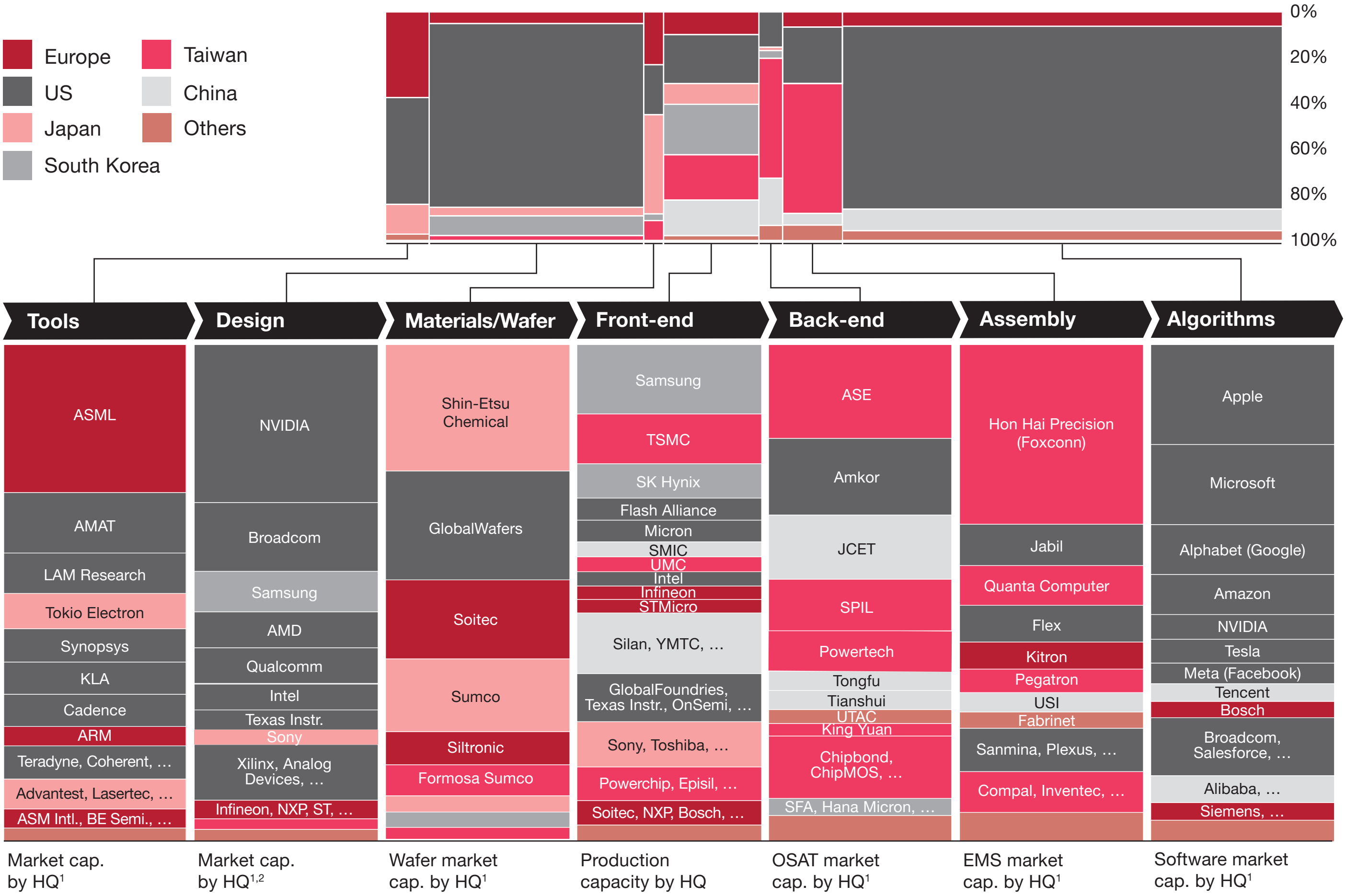
This report first gives an overview of the current situation in the global microelectronics sector. Afterwards, a holistic and sustainable microelectronics strategy is introduced. While the report mainly focuses on Germany, similar topics are relevant and similarly need to be considered in the European context. In the outlook, the investments required to realize the strategy are discussed briefly, along with the impact expected on a macroeconomic level.

2. Current situation

Understanding the global microelectronics landscape provides valuable insights into the strengths and opportunities for Germany and Europe in different areas. To proceed with formulating a comprehensive microelectronics strategy, it is essential to consider these key insights, acknowledging the critical role the different areas play in a country's digital sovereignty. Below, the most relevant findings with respect to the microelectronics value chain (*see Exhibit 3*), microelectronics types, and environmental aspects are highlighted.

EXHIBIT 3

Contribution to the microelectronics value chain by country/region



1 Only share of largest companies
2 Market capitalization of IDMs only considered half to account for other value creation
Source: SIA report 2021, SEMI World Fab Forecast 3Q22, Strategy& analysis

2.1 Microelectronics value chain

Design and algorithms emerge as major value contributors to the entire microelectronics value chain (*see Exhibit 3, previous page*). The United States has notably focused on these two key positions, with a significant market share (around 80% each). The US is also the only country with a relevant presence in all parts of the value chain.

ASML is the only provider of the **EUV lithography equipment** required for the smallest node sizes, making it a relevant control point for Europe. It is also the only real counterweight from Europe to the dominance of US companies in the tools market.

Chip design depends on highly specialized **electronic design automation (EDA) tools**. These are supplied mainly by just three companies: Synopsys, Cadence, and Siemens Mentor Graphics. This oligopolistic structure complicates access to these essential EDA tools, especially for small and medium-sized enterprises (SMEs).

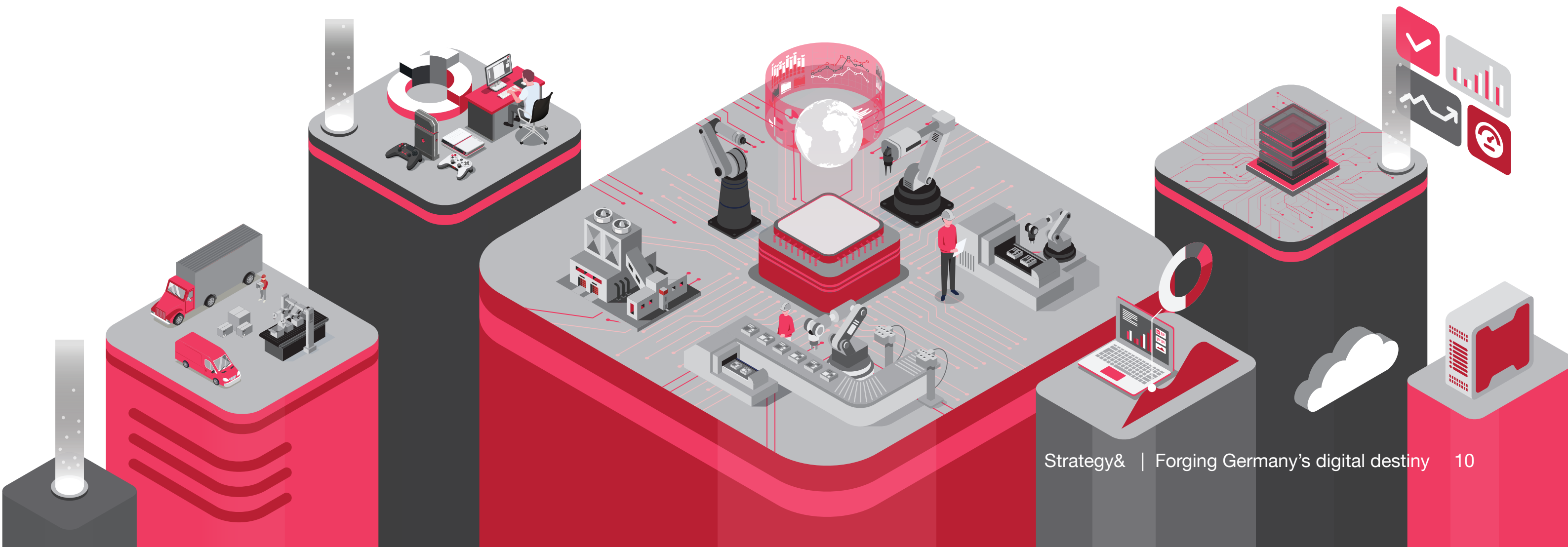
The largest **materials** share is defined by the raw **silicon wafers** required for chip production. Roughly 75% of all wafers are being fabricated in just four East Asian countries: Taiwan, South Korea, Japan, and China. Europe supplies around 6% of the global wafer demand, with Soitec and Siltronic being two noteworthy European players.

The same East Asian countries also control 75% of **global front-end production** capacity. China alone accounts for 24% of global installed capacity, as foreign companies such as the South Korean memory makers SK Hynix and Samsung also have significant fabrication sites there. Chinese production capacity covers all types of microelectronics and node sizes, except for the smallest nodes, where US trade restrictions on the required tools are preventing further growth.

Currently, the **smallest nodes** (sub-10nm), an important technology of the future, are dominated by Taiwan (TSMC), South Korea (Samsung), and the US (Intel), with Europe itself not yet having relevant production capacities. Recent developments such as the Intel production site for smallest nodes announced for Magdeburg, Germany, are the first signs that policymakers are closing this gap.

The **largest foundry service provider**, TSMC, announced a new front-end production site in Dresden, Germany, in a joint venture with Bosch, Infineon, and NXP. It will be TSMC's first fab in Europe and is planned to produce chips with node sizes of 12/16nm and 22/28nm, targeted at the automotive and industrial sectors.

Back-end manufacturing is mainly located in Southeast Asia. Advanced back-end technologies will become vital to further increase storage and computation densities, but also facilitate new applications such as co-packaged optics or AI-assisted sensor systems.



2.2 Microelectronics types

Germany's current stronghold lies in medium-sized node technology, particularly excelling in power electronics, sensors, optoelectronics, and safety microcontrollers.

Memory and micro-compute logic chips collectively contribute 40% of global microelectronics revenue.

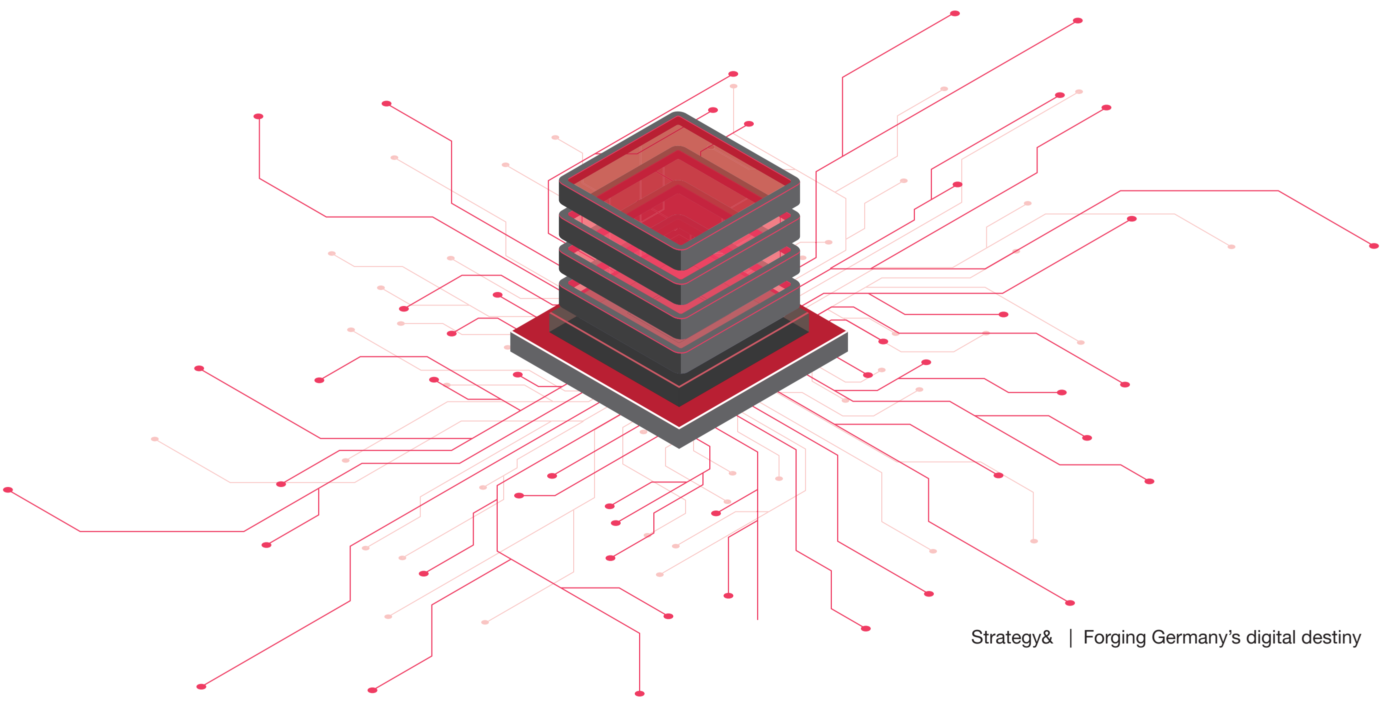
93% of overall **memory production** is located in just four East Asian countries. The memory market is heavily concentrated, with two South Korean companies, Samsung and SK Hynix, manufacturing around 60% of all memory chips globally.

Driven by the growing demands of electromobility and the energy transition, the **discretes** market – mainly comprising transistors - demonstrates strong growth. Leading players in this segment are distributed across Europe, the US, and Japan. European companies, such as Infineon, STMicroelectronics, Nexperia, and Bosch, contribute 25% of global production capacity.

65% of all **displays** are produced in China, and neither the US nor Europe have relevant production capacity. However, the emergence of micro-LED displays will drive strong growth in the coming years, introducing new opportunities for the global microelectronics industry.

China supplies over 80% of the global **photovoltaic cell** market, having a critical control point for the planned energy transition in Europe and around the world. Current state-of-the-art monocrystalline silicon cells used in mass production have efficiencies of up to 22%. While cell efficiencies well beyond 30% have long been demonstrated in numerous research laboratories, the commercialization of such cells is still progressing at only a slow pace.

Application-specific microelectronics offer a significant performance gain, reduced size, and power consumption, making them highly diverse and critical for various industries. While computation and communication tasks dominate this segment, the share of specialized AI accelerators is growing.



2.3 Industry environment

Environmental factors, and especially the available talent and the research infrastructure, are key aspects to consider. In the recent Strategy& study "Bridging the talent gap" concerning the European semiconductor talent market, it was found that Europe is likely to experience a shortfall of 350,000 professionals, in its pursuit of achieving a 20% market share by 2030. Furthermore, the industry has an increasing image issue, strongly lagging behind big tech companies in terms of attractive work environments. To successfully attract international talent, Germany too needs to step up and improve its reputation.

350k

professionals are likely lacking in Europe to reach a 20% market share by 2030.

With respect to research infrastructure, Germany has a strong research landscape, in both basic and applied research. However, successful transfer of research results into industrial applications and their commercialization is limited. Three main reasons have been identified for this situation: First, research is mainly performed in subcritical and scattered research teams with limited collaboration, as opposed to concentrated research centers, such as the IMEC in Belgium. To compound matters, university research is also often insufficiently professionalized. Second, applied research is lacking the necessary focus to jointly push topics through to commercialization. And third, especially for microelectronics, the process is often also very intensive in terms of capital expenditure.

SECTION 3

3. Microelectronics strategy

Based on the analysis, 14 strategic options to strengthen Germany's digital sovereignty have been identified. The findings have been validated with senior experts and managers in the microelectronics industry globally. The strategic options can be clustered in four coherent programs, based on their thematic similarity and implementation synergies.

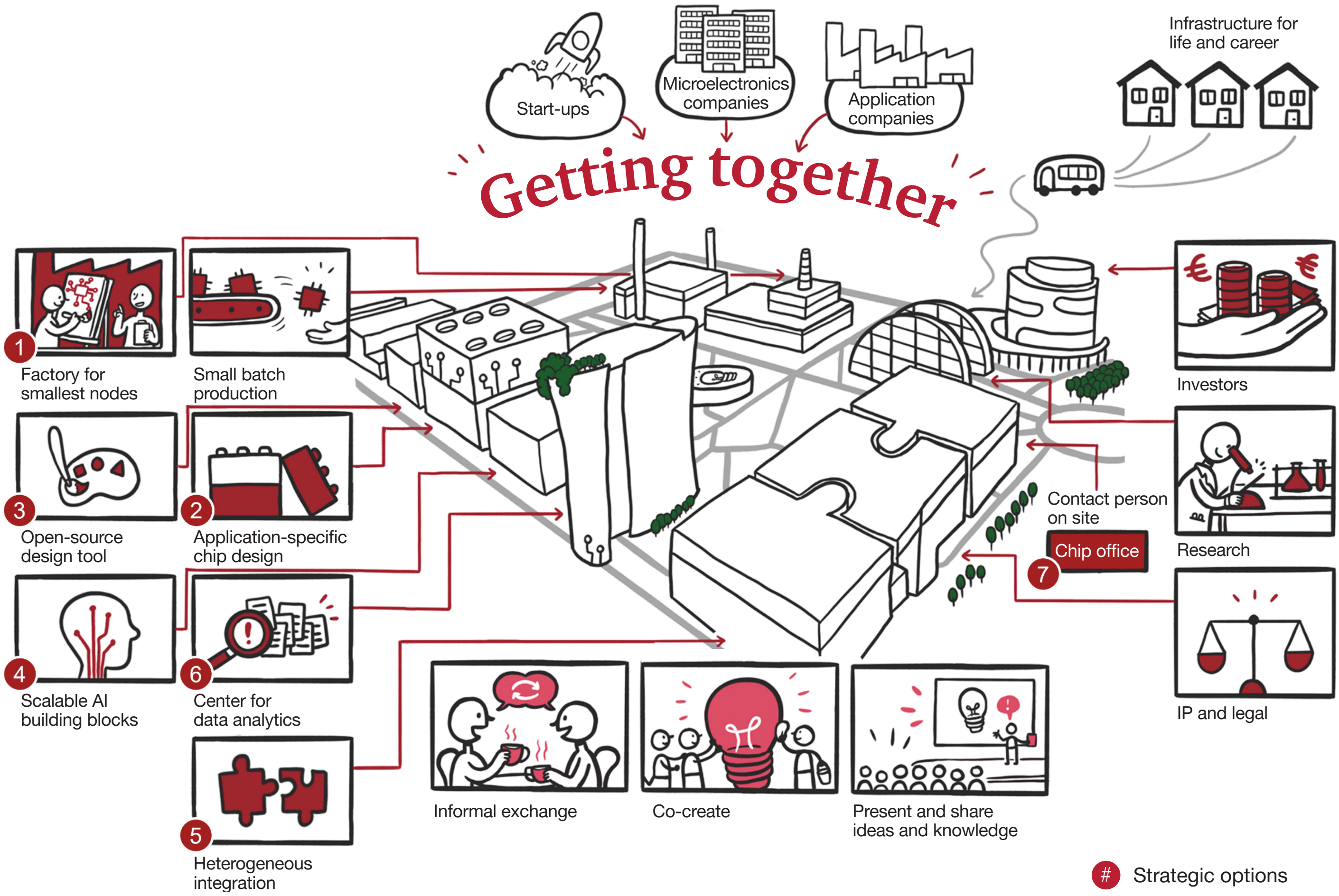
Program I: Building a holistic, sustainable chip design ecosystem

3.1

Chip design makes a major contribution to the overall value of microelectronics. New chip designs drive innovation and enable tailored and more efficient applications. Examples are manifold, from hardware-software co-optimized processing units, through to specific chips for software-defined systems. This can lead to the acceleration of specific algorithms, increased flexibility, shorter development cycles, and improved time-to-market, among other benefits. Enabling application industries to develop their own optimized designs empowers them to utilize these benefits and fosters innovation and customization in the microelectronics domain. However, chip design is currently strongly dominated by the US, albeit with European companies holding strong positions in the applications domain. High entry barriers hinder even large companies from successfully developing their own chips. However, with improved basic conditions, there is a clear opportunity even for smaller European companies to enter and establish a strong counterweight with their own chip designs.

The success of such efforts strongly depends on a prospering ecosystem, which needs to be established. This is the aim of the first strategic program. At its center, a chip design campus brings together relevant players of different sizes, from start-ups to global enterprises, and across the full microelectronics value chain, starting from research, via manufacturing, to the application. The campus should offer supporting structures, e.g., for legal matters, administrative work, intellectual property considerations, and funding opportunities. Informal exchange and knowledge-sharing between players will be critical for the ecosystem's success. There should be regular activities bringing employees from different companies together, exchanging ideas, and discussing the latest research and possible applications (*see Exhibit 4, next page*).

EXHIBIT 4
Vision of the chip design ecosystem centered around a collaboration campus



Source: Strategy& analysis

To support activities such as design for manufacturability or design for testability, it is paramount to have a close interaction between design teams and teams working on front-end and back-end processes. The design campus should therefore be built close to a manufacturing site. For example, the Intel fab for newest nodes announced for Magdeburg, Germany, could be a promising seed for such an endeavor.

1. Factory for smallest nodes

Smallest nodes (sub-2nm) are the cutting-edge technology that is driving applications such as artificial intelligence (AI), high-performance computing and the metaverse. They enable future technological advancements, along with high-tech military applications. Especially for this critical technology, Europe needs to be able to provide for its own essential demand. Establishing multiple new factories will therefore be crucial for Europe to secure a relevant production share and digital sovereignty. Otherwise, it will be highly dependent on production from other regions for these critical technologies. However, attracting production sites requires successful compensation of locational disadvantages when compared to Asia and the US, which are mainly driven by high government subsidies.
As a complement to this, policymakers should consider sourcing a minimum share of high-end chips from European manufacturing sites for critical applications, such as server processors in data centers. Moreover, to enable other players in the design ecosystem to manufacture their custom microelectronics, the new front-end facilities should have some reserved capacity accessible for third-party projects, e.g., via a foundry service model. As the manufacturing technology progresses further, focus should also be put on the ability to upgrade the site for even smaller node sizes in future.

2. Application-specific chip design

An essential part of the first program is to get companies, from start-ups to multinational corporations, to design their own chips. Chip designs that are specifically tailored and optimized for a certain application can yield significant performance improvements. The design campus is intended as a hub to bring together relevant players and know-how. Design specialists can provide input for projects and act as sparring partners. SMEs and start-ups, too, should receive sufficient support to create their own designs, thereby democratizing chip design. This will require service providers who support the design process end-to-end and should be integrated into the design campus. The government should further consider kick-starting this trend by establishing a chip design competition where the winning projects get additional funding support to realize their ideas.

3. Open source design tool

EDA tools are a basic necessity to create chip designs. Yet, the market is currently dominated by only three commercial providers, leading to a high entry barrier.
It can be lowered by creating and supporting an open-source alternative to the existing commercial design tools. A lower entry barrier encourages broader participation and innovation within the application industries, especially for SMEs and start-ups. Design for manufacturability has to be at the center of such efforts. Each foundry company has its own set of design rules that need to be considered. In the context of the design campus, particularly the factory for newest nodes should be able to be used for production of high-end chip designs.

4. Scalable AI building blocks

Artificial intelligence (AI) is a key technology and will be critical for a nation's digital sovereignty. This demands secure and trustworthy AI systems with a transparent chip architecture. Developing standardized, open-source building blocks in Europe not only fulfills these criteria, but also facilitates customization for specific applications – from small AI chips in wearables to powerful ones for data centers. Private companies, from the microelectronics, tech, and application industries, should actively participate in this shared effort. The recent announcement by Bosch, Infineon, Nordic, NXP and Qualcomm on investing in a company to advance adoption of the open-source RISC-V processor architecture might be a comparable approach on a different topic. Similar to newest nodes, policymakers should consider putting utilization requirements in place for trustworthy AI systems in safety-critical applications. Public research can also contribute to the advancement of the technology and should receive targeted funding.

5. Heterogeneous integration

Heterogeneous integration is the combination of separately-manufactured components and functionalities. It merges front-end and back-end technology. Utilizing standardized, reusable 2.5/3D chiplets and innovative packaging technology enables engineers to create customized microelectronics with a great range of variants, even at low volumes. Promoting this technology and the development of chiplets lowers the entry barrier and speeds up the development of own chip designs. This encourages specialized microelectronics solutions and can thereby greatly enhance overall system performance. As part of the design campus, a research center for heterogeneous integration, similar to IMEC, and a back-end production line with advanced packaging technologies should be established. Additional funding should be provided for companies to advance heterogeneous integration, similar to an IPCEI program, and to create chiplet designs. Because of their high strategic relevance, support should also extend particularly to power semiconductors, intelligent image sensors, metaverse displays, and integrated photonics.

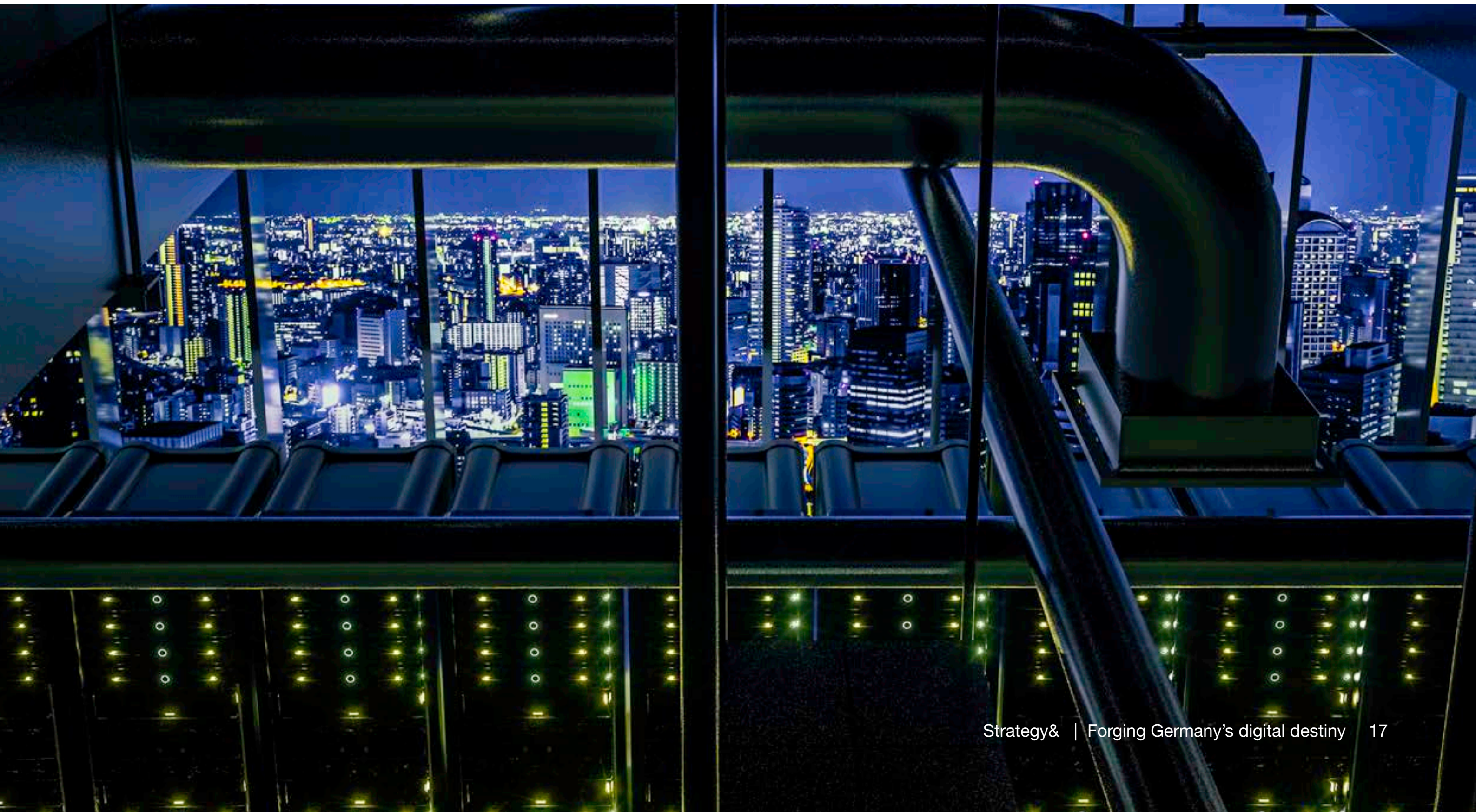
> "Artificial intelligence (AI) is a key technology and will be critical for a nation's digital sovereignty. This demands for secure and trustworthy AI systems with a transparent chip architecture."
>
> **Tanjeff Schadt,**
> **Partner Strategy& Germany**

6. Center for data analytics

Across the microelectronics value chain, large amounts of data are being created. Currently, this data is not systematically collected and utilized; at best, this occurs only within isolated silos. Yet, data analytics from the EDA tool to the final test post back-end is a major lever to increase speed of innovation and reduce production costs. Establishing a competence center for an end-to-end data analytics platform will harness the power of this data in the microelectronics industry, leading to, e.g., valuable insights, data-driven decision making, quality improvements, better design manufacturability, and reduced time-to-market. It is critical that the center is closely interconnected with all relevant players across the whole value chain to leverage its full potential. The data analytics platform itself should be open-source, to gain the trust of users. It has to offer secure, transparent, and scalable end-to-end data analytics tools for the microelectronics industry.

7. National chip office

A focused and coordinated approach is required to stay competitive in the quickly-evolving microelectronics industry. Public funding is one measure to provide focus and strategic direction. However, to maximize its efficiency, close coordination of all strategic measures is critical, along with organizational support and effective collaboration. Germany and Europe should therefore set up a central government office, akin to the CHIPS for America Offices, which acts as a coordination hub and serves as a point of contact for the microelectronics industry. The chip office should also support the application process for funding opportunities, e.g., by providing best-practices and sparring opportunities, or answering questions, and monitoring successful implementation. Especially where funding of applied research is concerned, the economic impact should be assessed and evaluated.



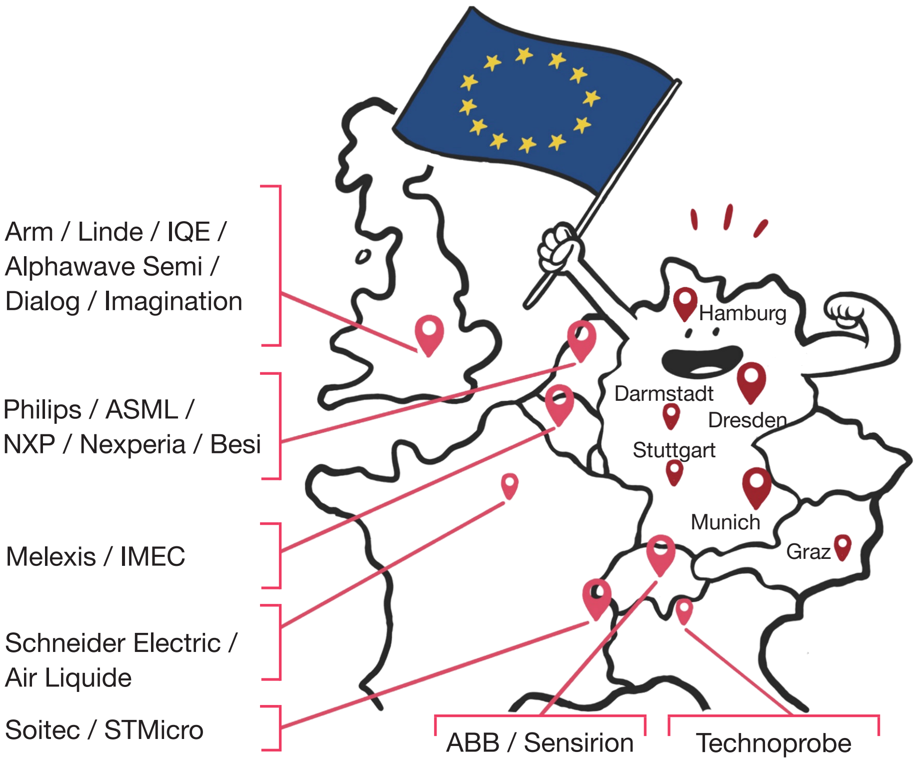
Program II: Strengthening and expanding the existing European microelectronics landscape

3.2

Europe already has a diverse and active microelectronics ecosystem with players across large parts of the value chain (*see Exhibit 5*). This is a stronghold that Europe should leverage and further support. Strategic investments in parts of the value chain can lead to benefits for the whole ecosystem, e.g., increased demand for materials and tools providers when investing in a new microelectronics fabrication site.

EXHIBIT 5

Overview of the German and European microelectronics landscape (non-exhaustive)



German companies

Tools
Mentor / ZEISS / Exyte / TRUMPF / AIXTRON / SÜSS MicroTec

Design / IDM
ams OSRAM / Bosch / Infineon / TDK / First Sensor / Semikron Danfoss

Materials
Merck / BASF / TDK EPCOS / Siltronic / SiCrystal

Front-end
X-FAB / GlobalFoundries

Assembly
Zollner

Application
Siemens

... and many other companies, start-ups, application companies and branches of international companies.

Source: Strategy& analysis

8. Existing ecosystem

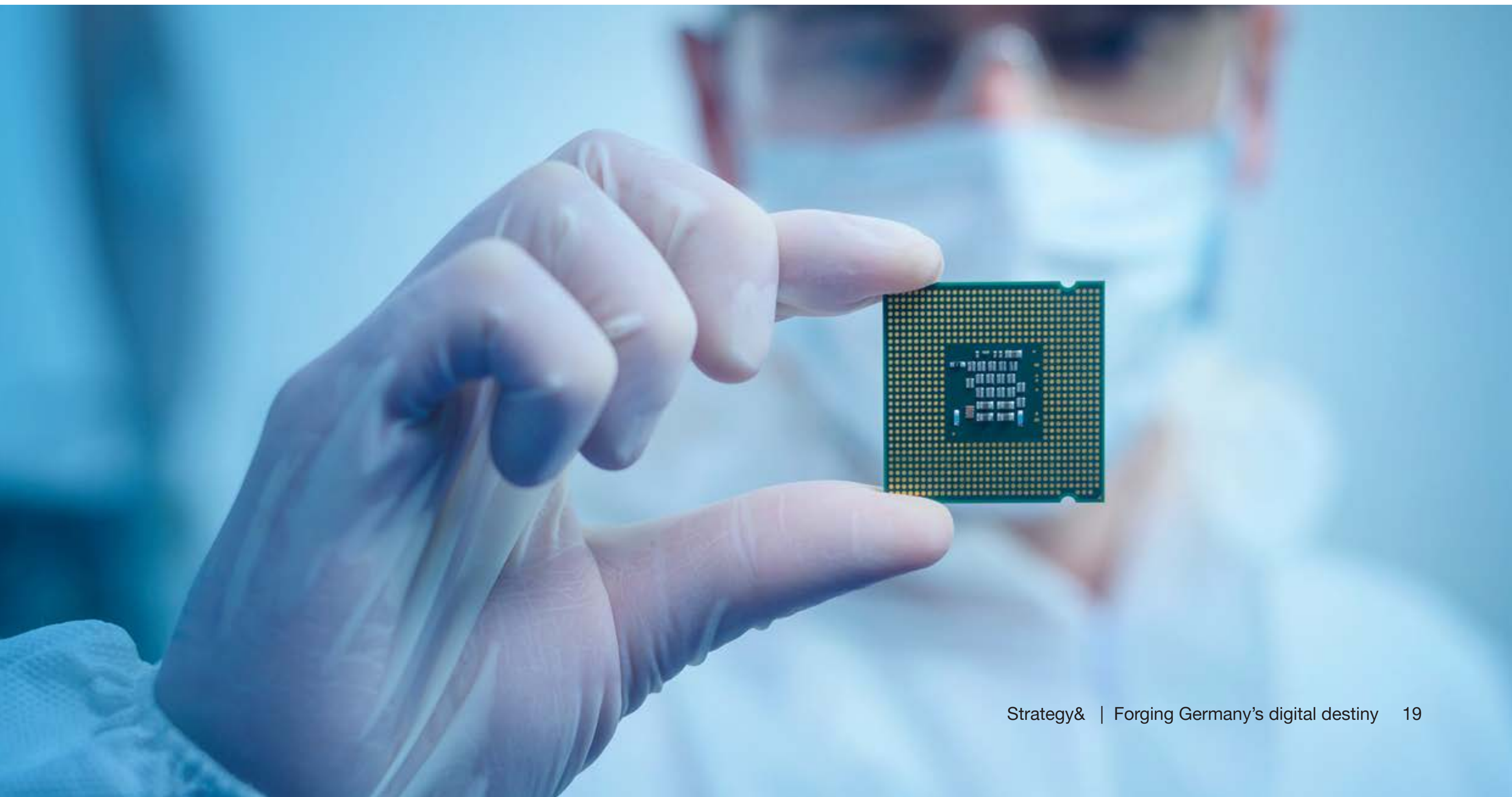
Many of the other strategic options already directly and indirectly strengthen and expand the existing ecosystem in different aspects. This includes the active integration of European companies and research institutions into the design campus presented in the previous program. Additionally, there is a need to establish unified and strong representation of industry interests, as these are currently scattered across multiple organizations, limiting their influence and effectiveness.

9. Medium nodes 16-80nm

Medium nodes, especially in the 16 to 80nm range, play a significant role in key European industries such as automotive and the Internet of Things (IoT). Investing in additional manufacturing capacity for such nodes is vital to strengthen the supply chain resilience of these industries and to serve their capacity demands. The new TSMC fabrication site announced for Dresden can only be a first step in this regard. Especially for critical infrastructure, microelectronics produced in Europe should be preferred, in order to support such efforts and safeguard digital sovereignty.

10. Wafer production

Wafers are a fundamental requirement for all microelectronics. Ensuring European production capacities to meet the basic demand guarantees a stable supply chain and reduces dependencies on external sources. New materials, such as SiC (Silicon carbide) and GaN (Gallium nitride), should also be considered when investing in new onshore wafer capacities.



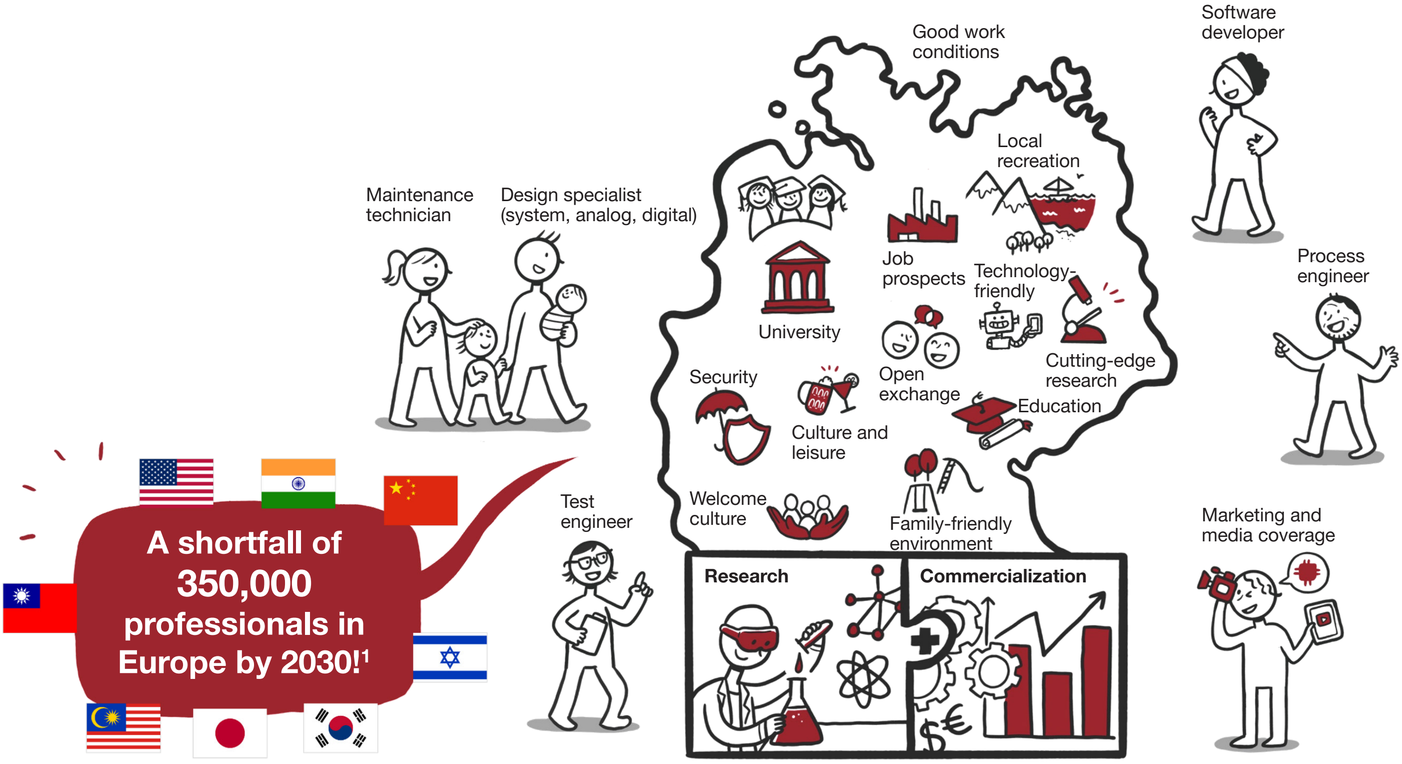
Program III: Providing a sustainable environment for the microelectronics industry

3.3

To achieve the goal of a 20% market share, Europe and Germany need to master significant growth. And while strategically-distributed public funding is definitely one prerequisite, providing a sustainable environment for the industry and professionals is another cornerstone required to achieve sufficient growth. Particularly with regard to the expected talent shortage, Germany has to be perceived as a go-to location for semicon professionals and their families. (*see Exhibit 6*).

EXHIBIT 6

Providing a sustainable environment for the microelectronics industry



1 Strategy& study "Bridging the talent gap", https://www.strategyand.pwc.com/de/en/industries/telecommunication-media-and-technology/bridging-the-talent-gap.html
Source: Strategy& analysis

11. Attractive working environment
The microelectronics industry depends on highly qualified professionals. By 2030, there will be a talent gap of roughly 350,000 people that needs to be addressed now. Microelectronics companies need to meet this challenge through a holistic people strategy and clear measures along the employee lifecycle. At the same time, creating an attractive environment for international professionals and their families is also essential to attract, educate, and retain talent in the industry, thereby supporting the anticipated growth in the ecosystem. This should also encompass dedicated marketing activities to strengthen the reputation of Germany and its microelectronics industry.

12. Research to application
Germany has a strong research landscape. However, systematic commercialization of research results is lacking. Professionalizing research structures and promoting closer collaboration with the industry facilitates the successful transfer of cutting-edge ideas into real-world applications and will sustainably strengthen the German and European economy. The design campus can be used to bring industry and research closer together and drive necessary investments in commercializing innovative research results.

Program IV: Other important strategic fields of microelectronics

3.4

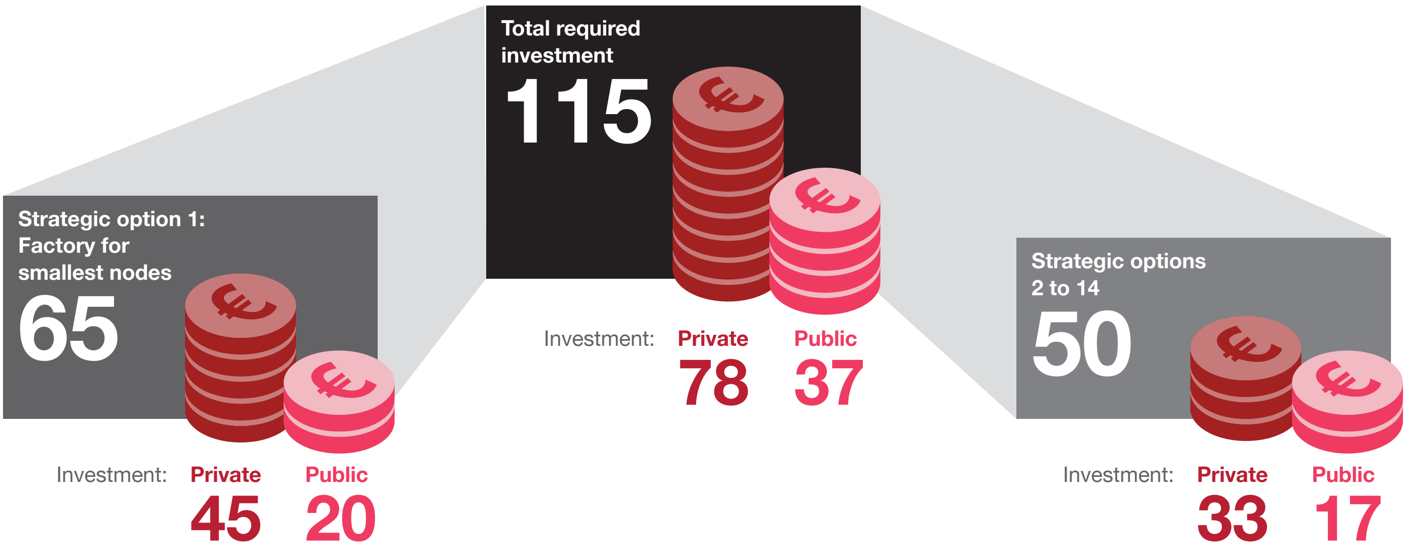
While the previous three programs already cover many important topics, the analysis revealed two more aspects of high strategic importance for Europe. These are addressed in this fourth and last program.

13. Memory production
Nearly all electrical devices depend on memory chips. Production capacities, however, are located in only a few, politically exposed countries such as South Korea, China, Japan, and Taiwan. Germany does not necessarily require its own production, but capacities for memory chips should be built up with partners, e.g., in Europe or the US. This addresses the widespread need for storage solutions and reduces the current volatile dependency.

14. Next-gen photovoltaics
Germany's and Europe's climate goals depend on a steep expansion of renewables, including photovoltaics. At the moment, over 80% of solar cells are manufactured in China. Germany already leads the field in research and development. What is still lacking is successful transfer to economically-viable production. Investing in European production capacities for next-generation photovoltaic cells with higher efficiencies (over 30%), e.g., perovskite solar cells, is therefore a promising action to reduce the dependency on Chinese manufacturers and promote the commercialization of innovative photovoltaic technologies.

4. Outlook: Time to join forces

EXHIBIT 7
Required investments in € billion over 10 years to implement the proposed strategy



Source: Strategy& analysis

The recently-adopted EU Chips Act, together with the European Commission's communication "A Chips Act for Europe", provide a new regulatory framework, within the limits of which state aid may be granted for semiconductor projects within the EU. However, the EU Chips Act itself has been endowed with a very limited budget of only € 3.3 billion in EU funds, which will largely be granted by competence centers as part of the well-established EU funding programs "Horizon Europe" and "Digital Europe". In consequence, the EU is heavily relying on its Member States to realize funding on their own account. On the other hand, in many countries there are no targeted funding programs for semiconductor projects; instead, general budgets are set within the framework of national recovery and resilience plans, often grouped under the generalized heading of "microelectronics". As the communication "A Chips Act for Europe" allows for approval of state aid of up to 100% of the funding gap for individual first-of-a-kind facilities (as defined by the EU Chips Act), Member States are more likely to use this opportunity to substantially fund large investments into semiconductor production facilities. Through this approach the Member States can simultaneously pursue other goals, including national security, regional development, strategic independence, and general economic policy. However, this may also result in a lack of targeted funding for truly innovative and groundbreaking projects. These large investments alone will not be sufficient to have a sustainable impact, thus further highlighting the necessity of a holistic and sustainable microelectronics strategy.

By pursuing the 14 strategic options presented here, Germany and Europe can lay a solid foundation for such a strategy, enhancing their digital sovereignty while driving innovation and fostering a thriving microelectronics ecosystem. Implementation, however, will require substantial investment. For Germany alone, an estimated € 115 billion of public and private investment is needed over the next 10 years. It is important to note that the EU goal of a 20% market share may vary depending on the types of microelectronics. The strategy presented does not aim to reach the goal uniformly across all types individually, but instead puts the focus on highly relevant strategic fields. Due to very high investment costs, the largest part (roughly € 65 billion) will be required for multiple fabrication sites for smallest nodes. Of that, approximately € 20 billion of public investment will likely be required to incentivize foreign companies to build their high-tech facilities in Germany. This aligns well with the recently-announced intention of the German government to utilize a similar amount from the Climate and Transformation Fund to boost domestic microelectronics production. However, considering the holistic picture, a further € 17 billion of public investment will be required, mainly to extend the production of wafers and medium nodes, and to establish and foster a design ecosystem (*see Exhibit 7, previous page*).

Only then can the synergy effects between the options truly come to fruition. Once the design ecosystem flourishes, the positive effect on the global macroeconomic situation can reach over € 3 trillion in 2035, similar to the current GDP of the entire United Kingdom or India. This also takes dependent applications and trends into account, such as the widespread application of AI and Metaverse use cases. The impact on the German economy alone can be up to € 600 billion. Looking solely at the microelectronics industry, over € 220 billion of additional revenue potential can be expected due to the strategic options in 2035.

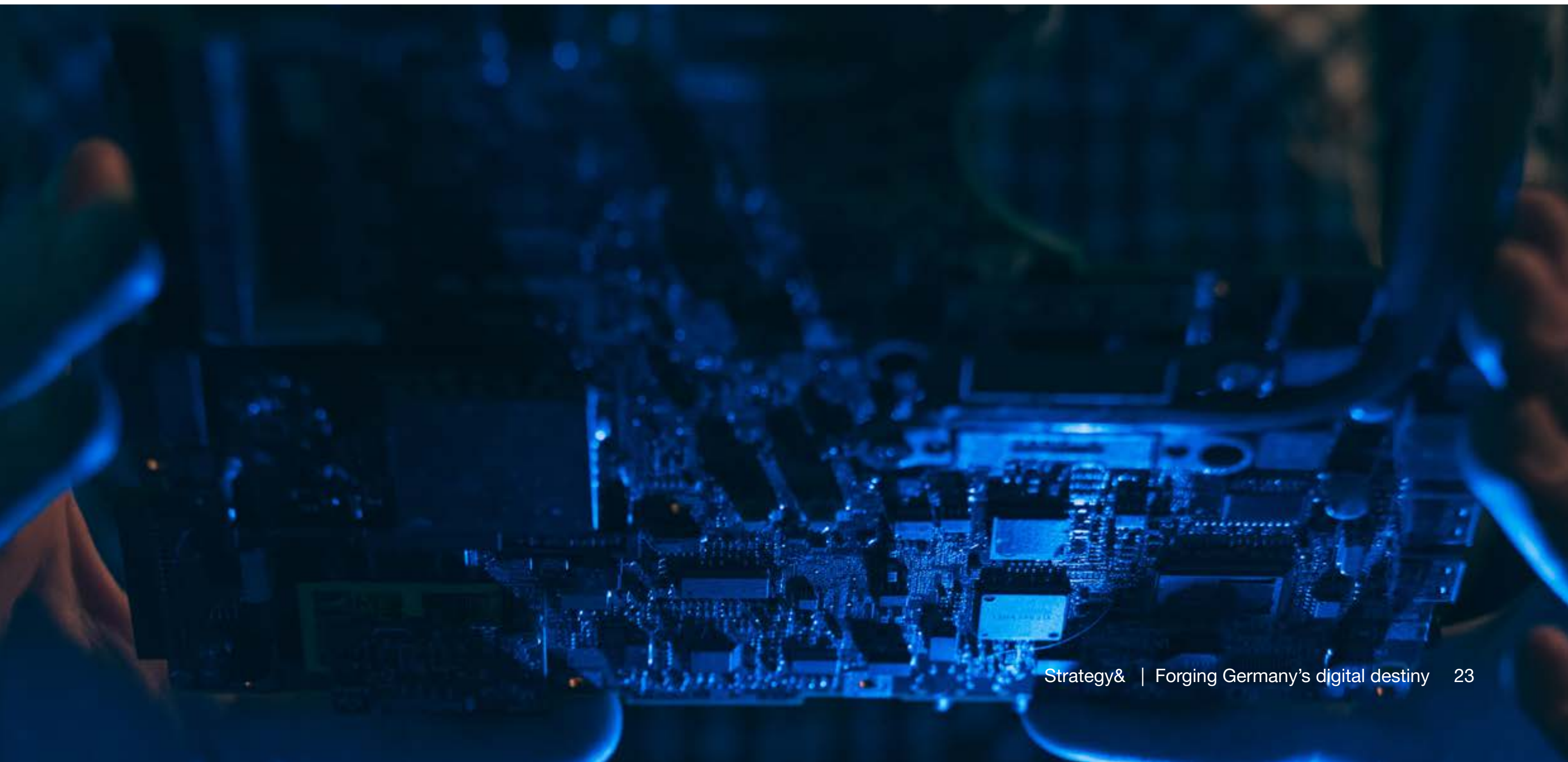
This makes it clear that, from a financial perspective too, a holistic strategy is in the interests of both government and industry. To achieve this, substantial commitment is required from all stakeholders. The government has to ignite the spark with targeted measures and support the ecosystem in coordinating and steering the efforts. Both sides have to invest strategically in the future of the industry and in Germany's digital sovereignty. But the industry has to align and take ownership of the strategy implementation. Measures such as the design campus hinge on the active participation of industry players across the microelectronics value chain. It is time to join forces and secure Germany's digital sovereignty.

€ 3 tn

can be the positive effect of the strategy on the global macroeconomic situation in 2035.

€ 200 bn

additional revenue potential can be expected for the microelectronics industry alone in 2035.



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