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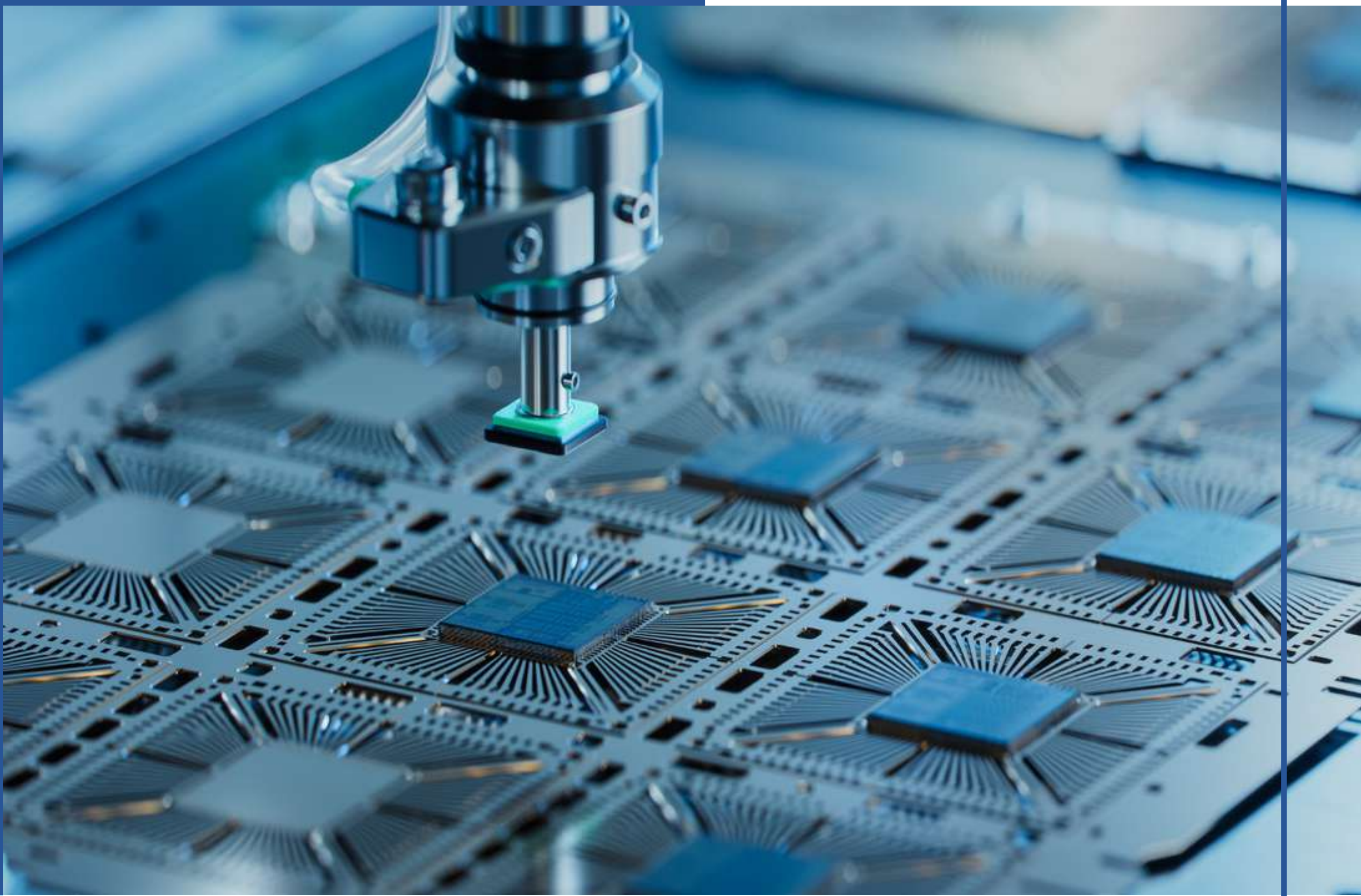

SEMICONDUCTORS AT THE CORE:

POWERING DIGITAL ECONOMIES AND SHAPING STRATEGIC DIGITAL FUTURES

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EXECUTIVE SUMMARY

Innovation in semiconductors drives growth throughout the economy, enabling advances in artificial intelligence and machine learning, aerospace and defence, quantum and high-performance computing, electronics and 5G/6G communications, transportation and infrastructure, energy and data centres, healthcare and biotechnology, and countless other fields. The semiconductor industry has become highly concentrated, which has reduced the resilience of critical technologies such as integrated circuits, advanced chip design, and manufacturing processes like extreme ultraviolet (EUV) lithography, all of which are essential for producing the microchips that power modern computers, smartphones, artificial intelligence systems, and global connectivity infrastructure. A few countries lead in the most advanced semiconductor capabilities, and only a small number of companies control key technologies like EUV lithography, which relies on EUV light to manufacture the smallest, most powerful chips. Combined with fragile supply chains, high investment and research expenses, market fluctuations, and geopolitical tensions, these factors threaten the sector's stability and the pace of global innovation.[1]

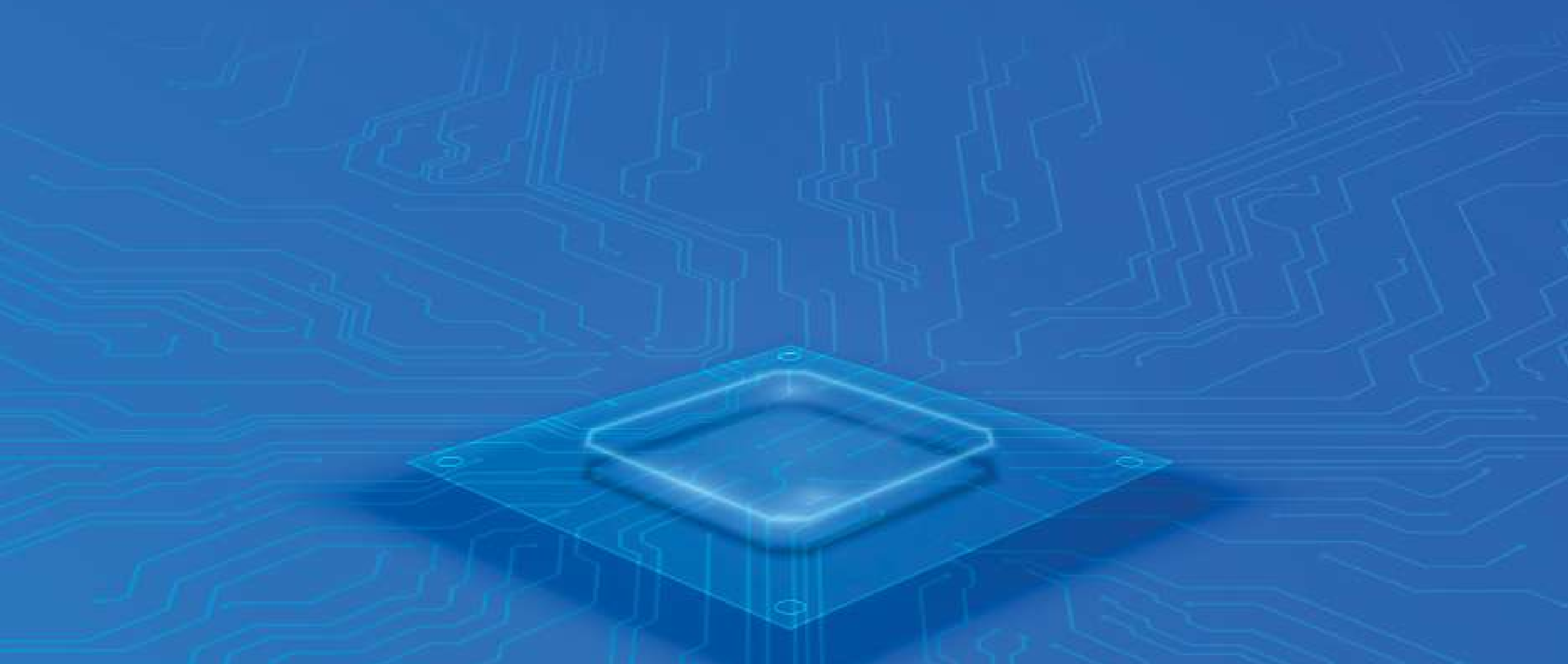
The global semiconductor market reached $630.5 billion in 2024, with projections indicating growth to $702.4 billion in 2025 and $1.29 trillion by 2030.[79] This growth is supported by a market and supply chain that by nature is highly specialised and interdependent, as design, fabrication, raw materials, equipment manufacture, and assembly remain concentrated in certain countries like Taiwan, China, and the United States.

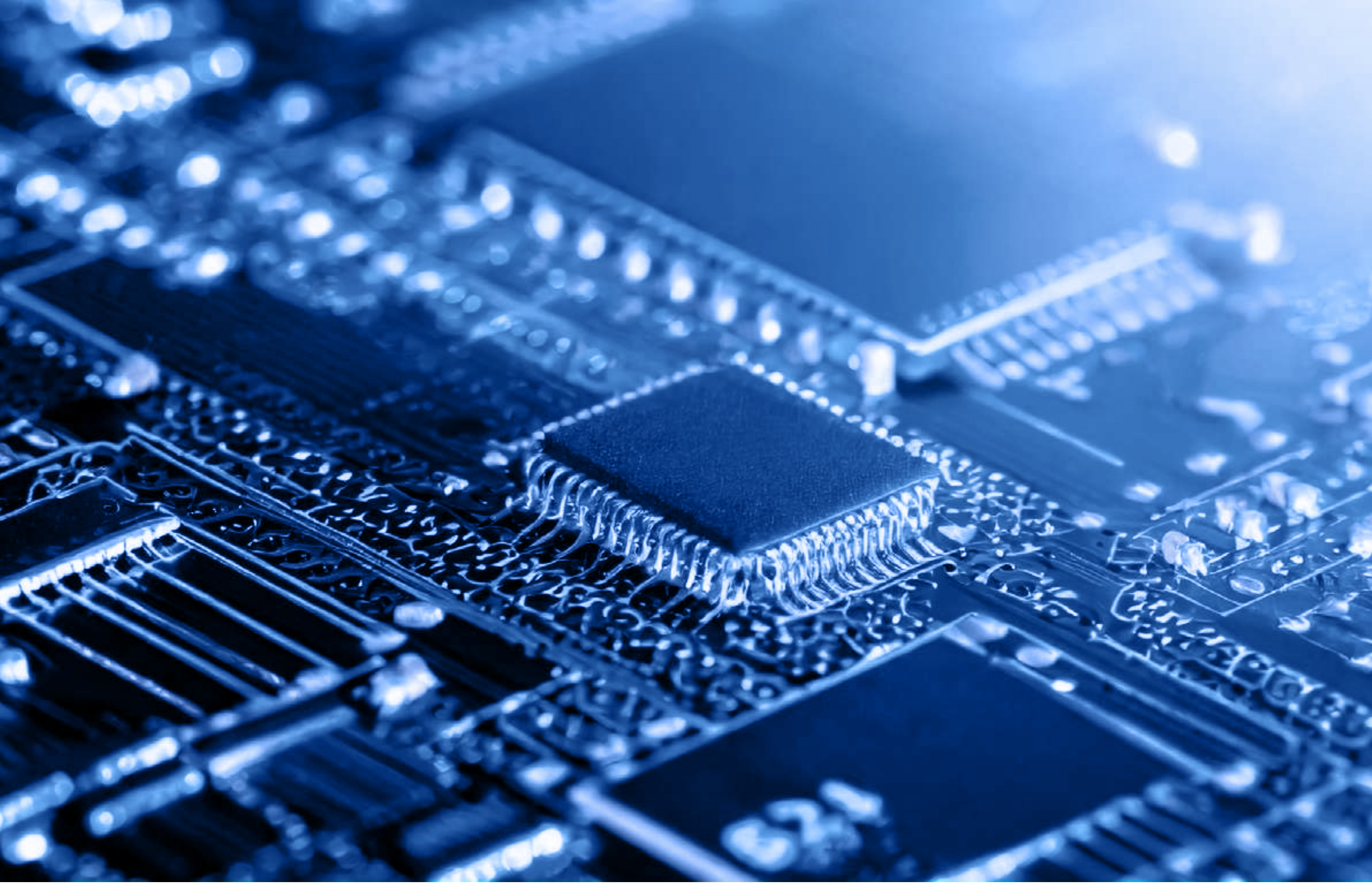
The paper provides an overview of leading countries in the semiconductor field, highlighting how governments worldwide are responding with various industrial strategies, including the United States Chips and Science Act, the European Union (EU) Chips Act, and major Asian investment programmes. These initiatives seek to secure domestic capabilities, attract investment, and build resilient supply chains. States like Vietnam are looking to become manufacturers, while regions like the Gulf Cooperation Council (GCC) Member

States are positioning themselves to become major players in the sector. For the Digital Cooperation Organisation (DCO) and its Member States, semiconductors represent both a challenge and an opportunity. The DCO Member States are advancing this agenda through the establishment of national Semiconductor Hub, the introduction of substantial investment incentives, talent development initiatives, and strategic partnerships with global technology firms to strengthen their position within the global semiconductor value chain.

This paper also examines current national policies, strategies, regulations, visions, and initiatives in the semiconductor field, focusing on two dimensions: global national strategies and the semiconductor landscape of DCO Member States, highlighting their emerging strengths and initiative.

By acting collectively, DCO Member States can enhance their technological sovereignty, secure access to critical semiconductor capabilities, and shape a more resilient and inclusive digital economy. This paper highlights the semiconductor industry's core challenges, ranging from supply chain vulnerabilities and high Research and Development (R&D) costs to environmental concerns, skills shortages, and the underrepresentation of developing economies. It puts forward strategic recommendations for policymakers, businesses, international organizations, educators, and investors, with special focus on the DCO Member States. The goal is to build resilience, foster innovation, and promote global collaboration, ensuring semiconductors drive a more inclusive and sustainable digital economy.





INTRODUCTION TO THE WORLD OF SEMICONDUCTORS

Semiconductors form the foundation of all modern electronics and their evolution from the first transistor in the mid twentieth century to today's advanced chips has transformed human civilisation. These tiny components enable a vast swath of modern technology, society, and economies, powering innovations such as AI, machine learning, data centres, and advanced communication.

The industry now stands at a critical juncture where semiconductors are viewed as strategic assets, critical to national security and to continued economic growth.

The semiconductor manufacturing process represents one of humanity's most complex industrial achievements. Modern chips contain billions of transistors operating at scales measured in nanometres, smaller than biological viruses.

Creating these devices requires hundreds of precisely controlled steps, from silicon wafer preparation through photolithography, etching, doping, and packaging. As another example, a single advanced fabrication facility costs more than $20 billion to build.[3]

The semiconductor industry divides into three primary segments (Figure 1): logic integrated circuits (IC) that process information, memory IC that stores data, and discrete/analogue/optoelectronic (DAO) chips that handle specialised functions like signal conversion and optical communication. Understanding these categories helps explain why different regions specialise in different aspects of semiconductor production.

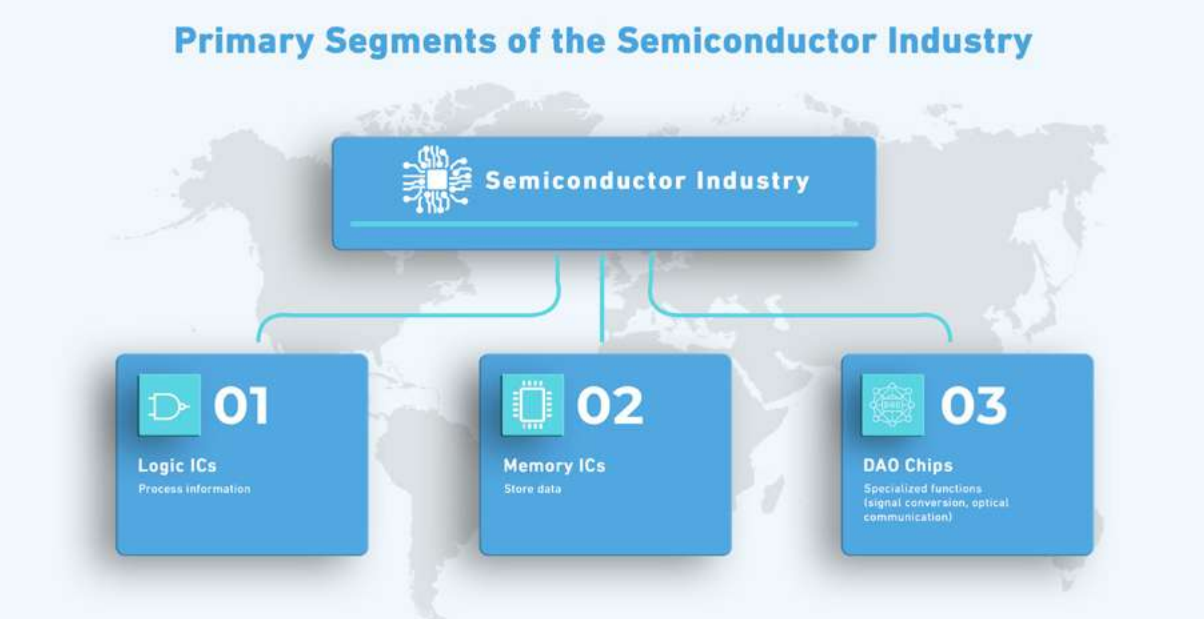


Figure 1:
Three Segments of Semiconductor industry

The Economic Value of the Semiconductor Industry

As previously mentioned, the global semiconductor market reached $630.5 billion in 2024, with projections indicating growth to $702.4 billion in 2025 and $1.29 trillion by 2030 [79] (Figure 2).

This represents a compound annual growth rate exceeding 10%, driven by artificial intelligence applications, 5G network deployments, automotive electrification, and industrial digitalisation.

Economic Value of the Global Semiconductor Industry

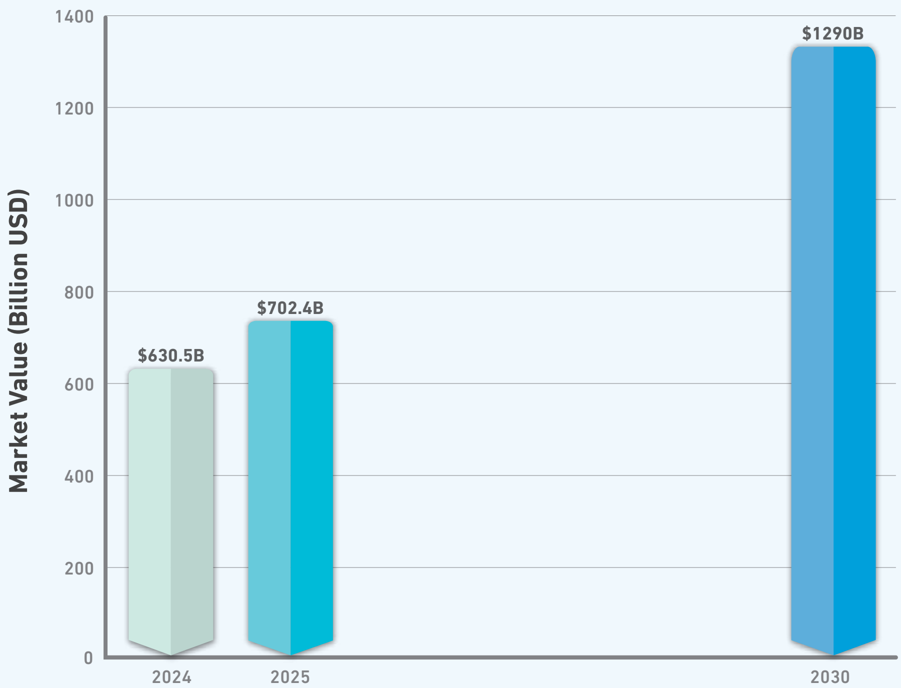


Figure 2:
The Economic Value of the Semiconductor Industry

Beyond direct revenues, semiconductors enable trillions in downstream economic value. The smartphone industry alone, worth over $500 billion annually, depends entirely on advanced semiconductors. Cloud computing services, generating over $600 billion in annual revenue, could not exist without continuous advances in processor and memory technologies.[4]

Semiconductors economic multiplier effect extends far beyond technology sectors as, for example, modern agriculture uses semiconductors in precision farming equipment, increasing crop yields while managing or even reducing resource consumption. Healthcare depends on semiconductor enabled diagnostic equipment, such as MRI scanners or portable ultrasound devices.

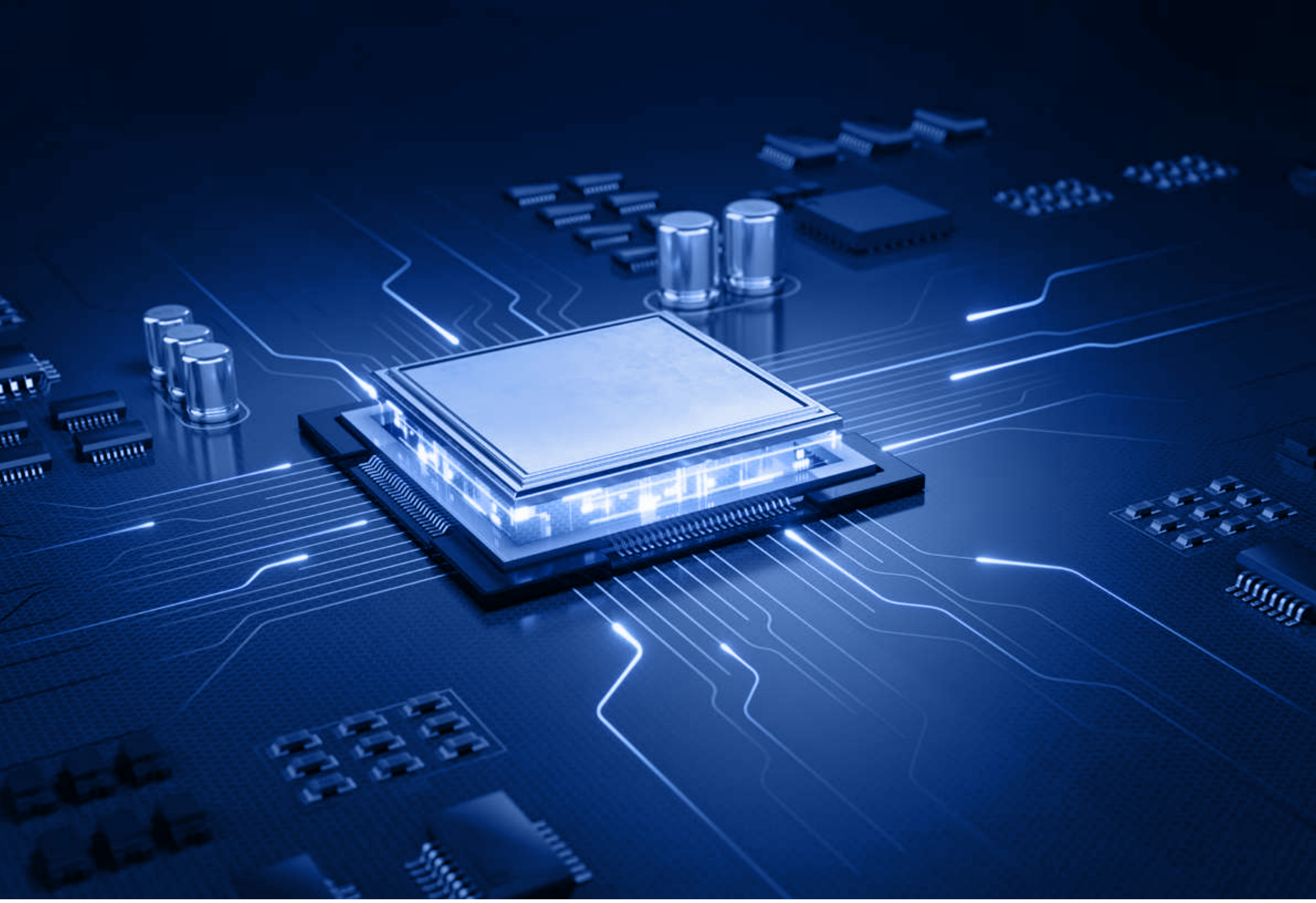
Financial services rely on high performance computing for risk analysis, fraud detection, and algorithmic trading. Even traditional manufacturing has been transformed by semiconductor enabled automation, with smart factories increasing productivity by 25% to 30% compared to conventional facilities.[5]

The automotive sector demonstrates this transformation, with electric vehicles containing semiconductors worth $1,000 to $2,000 per vehicle, compared to $300 to $400 in conventional vehicles.[6]

Regional economies benefit significantly from presence of the semiconductor industry, with East Asia of note. Taiwan-based semiconductor manufacturers accounts for 15% of GDP and provides high paying jobs for over 300,000 workers[7], while South Korea's memory chip industry contributes approximately 8% to national exports. Singapore's semiconductor assembly and test operations employ over 35,000 people and generate $100 billion in annual output.[8]

These examples show how semiconductor capabilities can contribute to economic resilience and technological sovereignty as countries without domestic semiconductor capacity face increasing vulnerability to supply disruptions and technological dependence.[2]

[1] Taiwan's status is subject to varying interpretations under international law and diplomatic practice



SEMICONDUCTORS AS A DRIVER OF THE DIGITAL ECONOMY

Role in Powering Digital Infrastructure and Services

Semiconductors form the foundation of digital infrastructure, enabling data processing, storage, and transmission at extraordinary scales with modern data centres containing millions of processors working in parallel to deliver cloud services to billions of users.

These facilities rely on a vast range of chips, including Central Processing Units (CPUs), Graphics Processing Units (GPUs), memory, networking, and power management circuits to support workloads from AI, streaming, or e-commerce. Industry estimates suggest that individual hyperscale centres can consume semiconductor components worth hundreds of millions of dollars, with flagship builds exceeding $1 billion in chip spend.[9]

Without continued semiconductor innovation and investment, the digital services that the modern world relies on would stall, making sustained technological advancement essential to survival and global digital transformation.

Telecommunications infrastructure depends entirely on semiconductor innovation, with clear examples in fifth generation (5G) networks requiring advanced radio frequency chips capable of processing signals at millimetre wave frequencies. Base stations need powerful processors to manage network traffic and implement software defined networking.

Edge computing facilities require specialised chips optimised for low latency processing. The ongoing transition to 5G alone is expected to drive $100 billion in semiconductor demand by 2030, while future 6G networks will require entirely new chip architectures.[10] Countries leading in semiconductor technology gain significant advantages in deploying next generation communications infrastructure. The AI revolution represents semiconductors' most recent and dramatic impact on the digital economy, where training large language models requires thousands of graphics processing units (GPUs) working in concert for weeks or months.

Inference tasks demand specialised AI accelerators optimised for specific workloads. NVIDIA's market capitalisation exceeding $3 trillion reflects the critical role of AI semiconductors in enabling this technological revolution.[11]

Companies and countries with access to advanced AI chips gain decisive advantages in developing and deploying AI applications[80] across sectors, like healthcare, finance, transportation, and national security.

Impact on Emerging Digital Technologies

Beyond enabling existing digital services, semiconductors drive many breakthrough innovations in emerging technologies.

Quantum computing requires specialised semiconductors operating at temperatures approaching absolute zero while autonomous vehicles depend on sensor fusion processors capable of real time decision making. Extended Reality (XR) applications need chips delivering unprecedented graphics performance within strict power constraints.

Biotechnology increasingly relies on semiconductor enabled gene sequencing and protein analysis. Each emerging technology creates new semiconductor requirements, driving continuous innovation in chip design and manufacturing.

Edge computing is a clear example of how semiconductors enable new computing paradigms, as processing data closer to its source reduces latency, improves privacy, and decreases bandwidth requirements.

This requires specialised chips optimised for specific applications: computer vision processors for security cameras, natural language processors for voice assistants, and sensor fusion chips for industrial Internet of Things(IoT) devices.

The edge computing semiconductor market is projected to reach $50 billion by 2030, creating opportunities for new entrants to challenge established players.[12]

Countries developing edge computing semiconductor capabilities position themselves for leadership in distributed computing architectures.

Semiconductors, through specialized hardware like Application-Specific Integrated Circuits (ASICs) and GPUs, drive blockchain performance and energy efficiency by supporting parallel processing and cryptographic computations.

Conversely, blockchain can improve semiconductor supply chain transparency and prevent counterfeiting[40].

Semiconductors, particularly via specialized hardware such as GPUs and high-performance processors, enable big data analytics by supporting the storage, processing, and real-time analysis of massive datasets.

In addition, big data informs semiconductor design, optimizes manufacturing, and improves operational efficiency[41] (Figure 3)

Big Data & Analytics	GPUs & processors for storage, processing & real-time analytics
Blockchain	ASICs/GPUs for mining, blockchain for supply chain transparency
Artificial Intelligence (AI)	GPUs/ASICs powering training & inference
Edge Computing	Specialized processors for vision, NLP, IoT
Biotechnology	Gene sequencing & protein analysis enabled by chips
Extended Reality (XR)	Chips for high-performance graphics under power limits
Autonomous Vehicles	Sensor fusion processors for real-time decisions
Quantum Computing	Specialized semiconductors at near-absolute zero

Figure 3:
Semiconductor Industry Impact on Emerging Digital Technologies

Integration into National Digital Strategies and Industrial Transformation

Nations increasingly recognise semiconductors as foundations for digital sovereignty and economic competitiveness, with the industry becoming increasingly more essential to continued economic resilience and growth. China's Made in China 2025 strategy explicitly targets 70% semiconductor self-sufficiency.

India's semiconductor mission aims to establish domestic chip manufacturing within five years.

The European Union seeks to double its global semiconductor production share by 2030.[13] These strategies reflect understanding that semiconductor capabilities determine national competitiveness in artificial intelligence, telecommunications, defence systems, and industrial automation.

Countries without semiconductor strategies risk technological dependence and economic vulnerability.

Smart manufacturing requires chips for robotics, machine vision, predictive maintenance, and supply chain optimisation, demonstrating how industrial transformation depends on semiconductor enabled digitisation.

Precision agriculture uses semiconductors in GPS guided tractors, drone surveillance, and automated irrigation systems. Smart cities deploy billions of sensors and processors for traffic management, energy optimisation, and public safety.

The industrial Internet of Things is projected to include [75] billion connected devices by 2030, each requiring multiple semiconductors.[14] Nations with advanced semiconductor capabilities can better capitalise on industrial digitalisation opportunities.

OVERVIEW OF LEADING COUNTRIES IN THE SEMICONDUCTOR FIELD

The global semiconductor industry exhibits extreme geographic specialisation, with different regions dominating specific value chain segments. The United States leads in chip design, controlling 47% of global market share through companies like Intel, Qualcomm, Broadcom, and NVIDIA.[15]

American firms particularly excel in processor architectures, with x86 and ARM designs powering most computers and smartphones worldwide. Silicon Valley's ecosystem of venture capital, research universities, and technology companies creates unmatched innovation capacity. However, the United States has lost manufacturing leadership, with domestic fabs producing only 10% of global capacity, although efforts are underway to reverse this slowdown.

Taiwan holds 68% of global advanced process capacity (16nm and below), with Taiwan Semiconductor Manufacturing Company (TSMC) specifically commanding 64% of the global foundry market and nearly 80% of extreme ultraviolet (EUV) generation processes such as 7nm and beyond.[38] TSMC's technological leadership stems from decades of focused investment, with annual capital expenditures exceeding $40 billion. The company's ecosystem includes over 500 local suppliers providing materials, equipment, and services.

Taiwan's semiconductor cluster in Hsinchu Science Park creates network effects that would take decades to replicate elsewhere. This concentration creates both efficiency gains and systemic risks for global technology supply chains.[39,86]

South Korea dominates memory chip production, accounting for over 60% of the global memory semiconductor market, with Dynamic Random Access Memory (DRAM) market share of over 70% and NOT AND Flash(NAND) market share of over 50%.[16] Korean companies excel at high volume manufacturing, producing billions of standardised chips annually and their vertical integration from research through production provides cost advantages and quality control.

South Korea invests over 1% of GDP in semiconductor research and development, the highest ratio globally. The government's K-Semiconductor Belt initiative aims to create the world's largest semiconductor cluster by 2030, with planned investments exceeding $450 billion.

China represents both the largest semiconductor consumer and fastest growing producer, though primarily in mature process nodes. Chinese fabs account for 15% of global capacity but only 7% of revenues due to focus on older technologies.[17]

Government subsidies exceeding $150 billion have created rapid capacity expansion, though technology restrictions limit access to advanced equipment. Chinese chip design companies like HiSilicon and UNISOC compete increasingly in mobile processors and telecommunications chips. The domestic market consuming 35% of global semiconductors provides natural advantages for local producers. China's strategy emphasises import substitution and indigenous innovation to reduce foreign dependence.

Japan maintains critical positions in semiconductor materials and manufacturing equipment despite declining in chip production. Japanese companies control 56% of global semiconductor material sales, including essential photoresists, silicon wafers, and specialty chemicals. This is alongside holding a 32% share in global semiconductor equipment.[18]

Tokyo Electron and Nikon remain leaders in lithography and deposition equipment with Japan's strength lying in precision manufacturing and materials science developed over decades. Recent government initiatives aim to restore advanced chip manufacturing through partnerships with TSMC and support for domestic ventures.

Europe accounts for approximately 8% of global semiconductor production but excels in specific niches. ASML monopolises extreme ultraviolet lithography equipment essential for advanced chip manufacturing. Infineon leads in power semiconductors for automotive and industrial applications.

STMicroelectronics specialises in sensors and mixed signal chips. European strengths include automotive semiconductors, where regional companies hold 37% market share. The EU Chips Act's €43 billion investment aims to achieve 20% global production share by 2030, though execution faces coordination challenges among EU member states.[19]

Monopoly Aspects and Political Concentration

The semiconductor industry's extreme concentration creates strategic vulnerabilities and geopolitical leverage points. ASML's monopoly on EUV lithography equipment represents the ultimate chokepoint, as no advanced chips can be produced without these €200 million machines.[20]

Only three companies globally, Intel, Samsung, and TSMC, can manufacture chips at 7nm or below. This concentration results from immense capital requirements and decades of accumulated expertise. Building competitive capabilities would require investments exceeding $100 billion and at least a decade of development.

Geopolitical tensions increasingly shape semiconductor markets through export controls, investment restrictions, and technology-related measures adopted by multiple countries. Technology restrictions flow in multiple directions, with various government implementing controls based on their national security assessments and strategic priorities.

These measures, while intended to safeguard strategic interests, affect global supply chains and influence significant volumes of commercial activity.

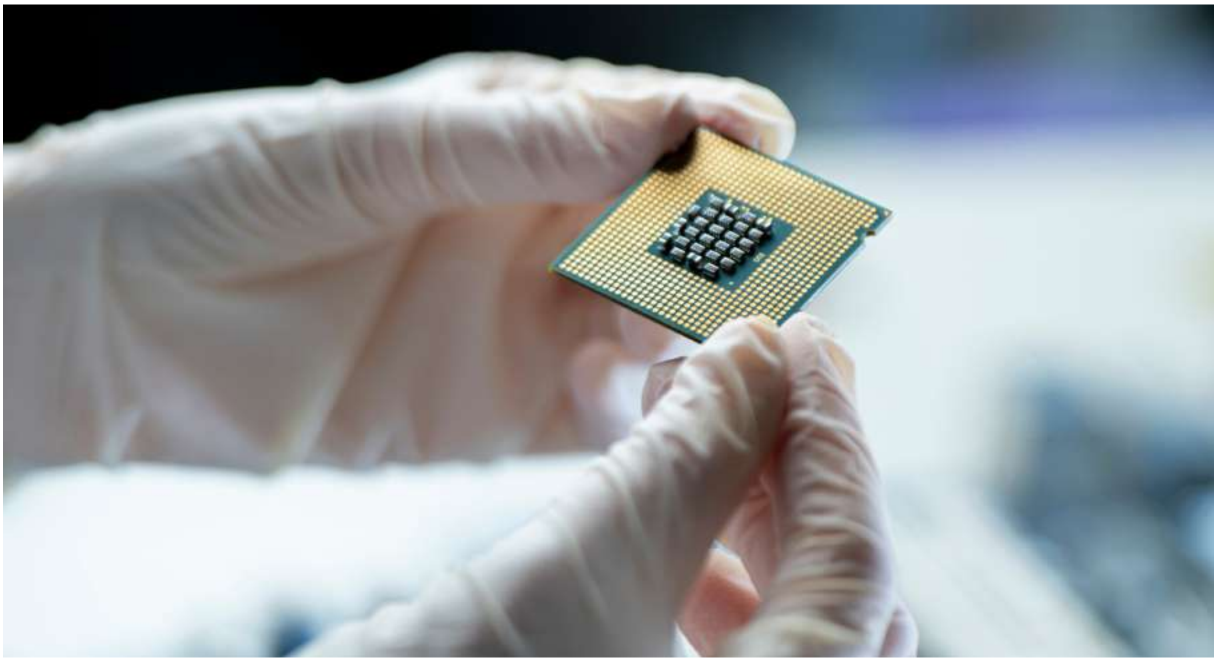
In some cases, restrictions extend beyond direct sales to include equipment servicing, software updates, and technical collaboration.

While such policies aim to strengthen national capabilities and resilience, they can also contribute to market fragmentation and reduce global innovation efficiency through duplicated research, parallel supply chains, and limited cross-border collaboration.[21]

Supply chain interdependencies create mutual vulnerabilities among semiconductor producing nations. Taiwan produces chips using American designs, Dutch equipment, Japanese materials, and Korean components. Disrupting any link breaks the entire chain so natural disasters, pandemics, or military conflicts could cause catastrophic supply disruptions as the industry's just in time manufacturing model provides little buffer against disruptions.

Building supply chain resilience requires balancing efficiency with redundancy, a challenge given semiconductor manufacturing's scale economy.

The industry's winner takes all dynamics reinforce concentration over time as leading edge manufacturers gain cost advantages through higher yields and better performance, attracting more customers and generating funds for further investment. Technology leaders can charge premium prices while maintaining market share.



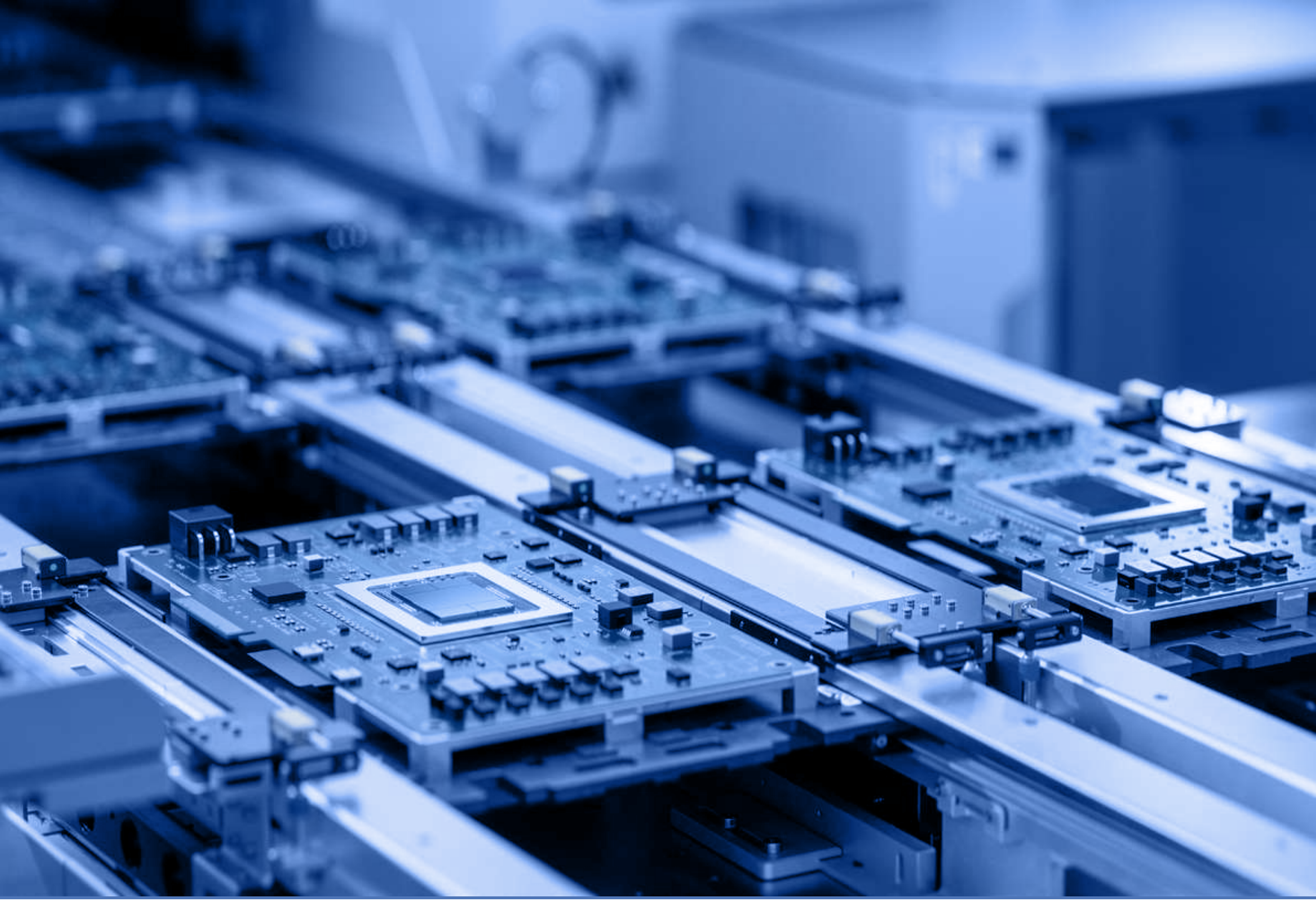
Catching up requires not just matching current technology but maintaining competitiveness while leaders continue advancing. Historical examples like Japan's rise in the 1980s and Korea's memory chip success required decades of sustained investment and government support.

Current concentration levels may prove more difficult to challenge given increased capital requirements and technological complexity.[22, 81, 82]

Investment barriers present additional complexities for the semiconductor surge, particularly as global semiconductor companies plan to invest approximately one trillion dollars in new fabrication plants through 2030, yet significant obstacles delay the full realisation of benefits from these investments.[37]

Beyond executing announced capital projects, five critical barriers may limit advancement in North American and European markets: underlying capital and operating cost dynamics, increasing material demands, offshore concentrations of raw materials and packaging, logistical challenges, and talent shortages.[23]

These structural impediments require coordinated policy responses to ensure investment effectiveness.



CURRENT NATIONAL POLICIES, STRATEGIES, REGULATIONS, VISIONS, AND INITIATIVES IN THE SEMICONDUCTOR FIELD

Global National Strategies

Major economies have launched comprehensive semiconductor strategies to secure domestic capabilities and strengthen supply chain resilience. The United States Chips and Science Act represents the most ambitious industrial policy in decades, allocating $39 billion in manufacturing grants, $13 billion for research and development, and establishing a 25% investment tax credit for semiconductor manufacturing.[24] Early results show promise, with over $450 billion in private investment announcements and projections to triple United States manufacturing capacity by 2032.[25]

The European Union's Chips Act aims to mobilise €43 billion in public and private investment, though implementation faces coordination challenges among EU member states with varying industrial capabilities and priorities.[26]

Asian nations continue expanding semiconductor investments despite already leading global production. South Korea's K-Semiconductor Strategy commits 550 trillion won ($450 billion) through 2030, creating the world's largest semiconductor cluster. Japan's semiconductor revival strategy includes $25 billion in subsidies to attract TSMC and support domestic ventures. India approved $15 billion for its Semicon India programme, attracting Foxconn, Vedanta, and other investors to establish fabrication facilities.[27] Vietnam positions itself as an assembly and test hub, leveraging lower costs and strategic location. These investments reflect recognition that semiconductor leadership determines future economic competitiveness.

China's semiconductor strategy combines massive subsidies, import substitution mandates, and indigenous innovation programmes. The National Integrated Circuit Industry Investment Fund has deployed over $150 billion across two phases. Government procurement preferences create guaranteed markets for domestic producers.

Technology restrictions have accelerated localisation efforts, with Chinese companies developing alternatives to foreign tools and materials. While technology gaps remain in advanced nodes, China leads in mature process capacity expansion. The strategy prioritises supply chain security over economic efficiency, accepting higher costs for reduced foreign dependence.

Semiconductor Landscape of DCO Member States

Digital Cooperation Organisation Member States are actively positioning themselves within the global semiconductor landscape. Current capacity gaps span design expertise, manufacturing infrastructure, and ecosystem development.

Most DCO Members States lack domestic semiconductor manufacturing and depend entirely on imports for their digital economy needs. However, certain DCO Member States possess advantages including strategic geographic locations, available capital for investment, and growing domestic markets for semiconductor applications.

The demographic dividend of DCO Member States provides potential workforce advantages, with over 60% of the population under 30 years old. Universities across DCO Member States graduate thousands of engineers annually who could be trained for semiconductor careers. Several Member States offer competitive energy costs and land availability for semiconductor facilities.

Strategic locations between Asian manufacturing and European markets create coordination advantages. Growing domestic demand for semiconductors in automotive, telecommunications, and consumer electronics provides market opportunities. These advantages could attract global semiconductor companies seeking diversification from concentrated Asian production. Following are the key highlights about the DCO Member States semiconductors vision and initiatives:

Saudi Arabia

The Kingdom of Saudi Arabia's emerging semiconductor strategy demonstrates how DCO Member States can leverage their unique advantages to enter this strategic industry, serving as a use case for others seeking to build capacity and competitiveness.

The Kingdom launched its National Semiconductor Hub in June 2024 with ambitious targets, including establishing 50 chip design companies by 2030, training 5,000 semiconductor engineers, and creating a self-sustaining innovation ecosystem.[28] Initial investments exceed $6.4 billion, including funding for Alat's advanced technology manufacturing initiatives.

The strategy focuses on chip design rather than manufacturing, recognising the lower capital requirements and faster capability development in fabless operations. Partnerships with global leaders including Foxconn, SoftBank, and King Abdulaziz City for Science and Technology (KACST) accelerate knowledge transfer.

The Kingdom's semiconductor ambitions align with Vision 2030's economic diversification goals. Abundant capital from the Public Investment Fund (PIF) enables long term investments typical of semiconductor development and their strategic location between Asian suppliers and growing Middle Eastern markets provides coordination advantages. Planned NEOM smart city creates guaranteed demand for advanced semiconductors across transportation, energy, and communications applications. The King Abdullah University of Science and Technology (KAUST) semiconductor research programme develops local expertise through partnerships with international institutions.[29]

Saudi Arabia's approach emphasises ecosystem development over isolated projects, preventing a siloed approach that may lead to duplication and wasted resources. The National Semiconductor Hub provides shared design tools, testing facilities, and prototyping capabilities that individual companies could not afford. Talent development programmes include undergraduate curriculum reform, international exchange programmes, and industry partnerships for practical training.

Investment incentives include tax holidays, subsidised facilities, and guaranteed government procurement for qualified products. Regulatory frameworks protect intellectual property while facilitating technology transfer. This comprehensive approach addresses multiple success factors simultaneously rather than focusing on single elements.

Early progress demonstrates momentum despite challenges and multiple international companies have announced Saudi partnerships or investments. Local universities have launched semiconductor engineering programmes in collaboration with industry to advance the development of smart chips, focusing on applications aligned with national priorities such as renewable energy management, transportation, and telecommunications. While King Abdulaziz City for Science and Technology (KACST) has reported the design and manufacturing of 25 advanced electronic chips by Saudi engineers, marking progress in building domestic semiconductor capabilities [78]

Success requires sustained commitment over decades, as semiconductor capabilities cannot be developed quickly. The Kingdom's financial resources, government commitment, and strategic partnerships place the Kingdom in a strong position for long term success, though execution risks remain significant.

Oman

Oman has embedded semiconductor development into its Vision 2040 strategy and digital economy agenda, led by the Ministry of Transport, Communications & Information Technology (MTCIT)[47]. The country achieved a milestone by developing Oman-1 and Oman-2, its first locally designed integrated silicon chips[48], while partnering with regional and international investors through Memorandum of Understanding (MoUs) to advance semiconductor projects in Salalah Free Zone.

A flagship Semiconductor Centre of Excellence (SCOE) has been tendered to strengthen training, research, skills development, and early-stage prototyping[49].

In 2025, MTCIT and the Ministry of Labour partnered with an international firm's Kaynes Semicon to establish a VLSI design company in Oman, training[80] Omani engineers in advanced chip design[75]. To attract global players, Oman leverages its Special Economic Zones, Duqm (SEZAD), Salalah, and Knowledge Oasis Muscat, which offer long tax holidays, 100% foreign ownership, customs exemptions, and investor-friendly services through a one-stop system.

The SEZAD incentive framework further ensures streamlined business setup, free repatriation of profits, and modernized customs processes, creating a competitive ecosystem for advanced technologies. Together, these measures position Oman as an emerging hub for semiconductor design and innovation within the region[50].

Kuwait

Kuwait does not yet have a standalone semiconductor strategy, but its ambitions are framed within Kuwait Vision 2035 and the forthcoming National Industrial Strategy 2035, which aim to diversify the economy and position the country as a hub for innovative and sustainable industries. Within this framework, prioritized sectors include advanced manufacturing, nanotechnology, and AI-enabled devices, all of which provide natural entry points for semiconductor-related development[44].

The Kuwait Direct Investment Promotion Authority (KDIPA) supports potential investors through significant incentives, including up to ten years of tax holidays, customs exemptions, land-use rights, and strong legal guarantees, creating a favourable climate for high-tech industries.

At the research level, Kuwait University and the Kuwait Institute for Scientific Research (KISR) operate nanotechnology and advanced materials programs, with facilities and patents that strengthen upstream capabilities for semiconductor applications.

These research and policy foundations provide a basis for future growth in chip design, advanced packaging, and electronics innovation. Together, Kuwait's industrial policy, investment incentives, and research programs align with its broader digital economy agenda and create pathways to expand its role in global technology value chains[45].

The Hellenic Republic (Greece)

Greece is stepping onto Europe's semiconductor stage with bold initiatives to boost innovation, skills, and industrial collaboration. At the heart of this effort is the Hellenic Chips Competence Centre (HCCC)[54], launched on 1 June 2025 under the EU "Chips for Europe" initiative and the European Chips Act[55,26].

HCCC unites HETiA, Greek research institutions, and universities to advance semiconductor research, develop specialized talent, and bridge industry-academia collaboration. With a €7 million budget, the Centre offers access to IC design platforms, pilot lines, high-performance computing, and AI-powered design tools. It also drives knowledge transfer through prototyping, co-development, and the creation of specialized components for AI, cryptography, biomedical electronics, and quantum technologies. Training programs cover circuit design, embedded systems, IoT, and advanced applications, ensuring a highly skilled workforce. By linking Greek innovation with European technological infrastructure, HCCC strengthens Europe's semiconductor autonomy and resilience. These efforts align with the European Chips Act, reinforcing Europe's digital and green transition while enhancing competitiveness[54].

Islamic Republic of Pakistan

The semiconductor industry requires a vast pool of skilled manpower, with more than a million additional workers needed globally by 2030. Pakistan, with one of the world's largest youth bulges, is well-positioned to seize this opportunity through long-term, structured initiatives across the semiconductor value chain.

The Ministry of Information Technology and Telecommunication (MoITT) has drafted a National Semiconductor Policy and Action Plan, envisioning Pakistan as a hub for design, manufacturing, and Assembly, Test and Packaging (ATP).

Its goals include developing a market-ready workforce, building a competitive ecosystem for IC design, verification, and R&D, and achieving self-sufficiency in critical chip design and fabrication[42] by 2047.

The policy framework focuses on incentives, infrastructure, human resource development, industry collaborations, and innovation-driven R&D. A Rs. [10] billion national semiconductor funds have been proposed to support investment, research, and startups, alongside fiscal incentives such as tax rebates and duty exemptions. Recognizing design as a lower-capex entry point, government agencies are promoting chip-design clusters to leverage local talent and expand exports of design services. Strategic roadmaps emphasize phased growth (starting with design, testing, and legacy-node manufacturing, and scaling towards advanced capabilities) supported by university–industry partnerships[42].

The Pakistan Semiconductor policy also proposed setting up semiconductor facilitation offices in key global tech hubs, such as Silicon Valley and Shenzhen to attract United States. and Chinese Semiconductor design centres, streamline business connections, and enable human talent mobility via a Pakistan Semiconductor Association (PSA)[43].

In parallel, the Government of Pakistan has launched the Inspire Initiative, backed by PKR 4.5 billion, to train 7,200 youth in semiconductor design and research, further strengthening the national talent pipeline and ecosystem [77].

Nigeria

Nigeria is positioning itself to participate in the global semiconductor value chain through policy, research, and resource-driven initiatives. The National Information Technology Development Agency's (NITDA) Strategic Roadmap and Action Plan (SRAP 2024–2027) emphasizes skills development, research clusters, under pillar 2, 'Build a robust Technology Research Ecosystem', to enable chip design and R&D[51].

Public and private investments are building capabilities in AI, hardware engineering, and device labs, creating a talent pipeline for semiconductor packaging and electronics manufacturing.

With abundant critical minerals such as silicon, tin, tantalum, gold, and niobium, Nigeria also has the raw material base to support upstream supply chains[52].

Semiconductor investment could help diversify the economy, reduce reliance on petroleum, strengthen the naira, and establish competitive technology exports. Leveraging its diaspora, Nigeria is exploring opportunities to transfer expertise through mentorship programs, infrastructure for cleanrooms, and international collaborations.

Aligned with Africa's broader push, Nigeria benefits from a young STEM-driven workforce and strategic location between Europe, the Middle East, and Asia, enhancing its appeal for semiconductor manufacturing. Collectively, these measures position Nigeria as an emerging hub in the global semiconductor supply chain.

Qatar

Qatar is positioning itself in the global semiconductor landscape through targeted investment, research, and innovation. In 2025, Invest Qatar partnered with Ardian and Silian Partners to attract semiconductor and AI firms, establish a local industry presence, and foster knowledge exchange[56].

This builds on the Qatar Investment Authority's 2024 intent to anchor Ardian Semiconductor's fund, reflecting semiconductors as a priority investment area alongside its stake in Kokusai Electric[57].

Domestically, Qatar Science & Technology Park (QSTP) and the wider Qatar Foundation ecosystem provide incubation and infrastructure for tech start-ups[58], while Qatar University advances projects on 2D semiconductor materials, such as flexible sensors for the oil and gas sector[59].

Momentum is further supported by events like Hamad Bin Khalifa University (HBKU) 2025 international microelectronics conference, which connected regional and global experts[60].

Together, these initiatives combine sovereign investment with academic and industrial collaboration, laying the foundation for a resilient, innovation-driven digital economy that advances inclusivity, sustainability, and technological sovereignty

Morocco

Morocco is emerging as a competitive hub in the global semiconductor value chain, leveraging its strong automotive industry to attract investment in chip assembly, testing, and packaging.

STMicroelectronics has expanded its back-end plant in Bouskoura, adding 7,000 m^2 of cleanroom space for advanced silicon carbide products critical to electric vehicles, while also establishing a design and software development centre in Rabat to move up the value chain[61].

National research institutions such as MAScIR further strengthen the ecosystem by fostering R&D in microelectronics, nanomaterials, and applied sciences, bridging academia with industry needs[62]. These combined private-sector investments and research capacities position Morocco as a rising player in high-tech manufacturing. Morocco's approach reflects a broader ambition to integrate into global semiconductor supply chains and drive its digital economy transformation.

Hashemite Kingdom of Jordan

The Hashemite Kingdom of Jordan is positioning itself as an emerging player in the semiconductor value chain through national strategies, industrial reforms, and global partnerships.

The REACH2025 Digital Strategy and the 2024–2028 Industrial Policy prioritize high-value manufacturing and ICT, aligning digital innovation with advanced electronics[63]. The Government of Jordon, through Ministry of Industry, Trade, and Supply has rolled out initiatives such as the EU-supported Capacity Building Project, Industry Development Fund to boost competitiveness and attract investment[64].

In parallel, the Ministry of Communications and Information Technology, together with other entities, introduced a national electronic chip design competition[76]. Favourable frameworks, including the Investment Environment Law, free development zones, and ICT tax incentives, further strengthen Jordan's appeal for FDI in semiconductors and hardware[65,66.]

Internationally, the Jordanian embassy in Washington, with the Consumer Technology Association, spotlighted Jordan as a future partner in the global chip supply chain, leveraging its skilled talent and United States trade advantages[67].

On the talent front, Princess Sumaya University for Technology (PSUT) trained over 100 engineers in semiconductors and microelectronics[68], while Golden Electronics and Synopsys launched a very large-scale integration (VLSI) talent acceleration program to equip graduates with industry-grade tools[69].

Together, these efforts signal Jordan's intent to embed semiconductor development within its broader digital economy and industrial modernization agenda.

Kingdom of Bahrain

The Kingdom of Bahrain is aligning its Industrial Sector Strategy (2022–2026) with the global semiconductor value chain, focusing on advanced manufacturing, Industry 4.0 and digital transformation[70].

To attract investment, Bahrain offers competitive incentives such as 100% foreign ownership, favourable tax policies, low setup costs, and customs duty exemptions for industrial manufacturing[71].

These measures have already borne fruit: international chipmaker Polymatech has committed over $ 16 million to establish a semiconductor facility in the Hidd Industrial Area, producing critical 5G and 6G components under the Atri brand[72]. To support quality and interoperability[72]. Bahrain has also adopted international semiconductor standards[73] (e.g., IEC 63244-1).

Meanwhile, academic institutions including the University of Bahrain and the Royal University for Women are building talent pipelines through programs in electronics, embedded systems, and microelectronics. Collectively, these initiatives position Bahrain as an emerging GCC hub for semiconductor manufacturing and digital economy innovation[74].

KEY CHALLENGES FACING THE SEMICONDUCTOR INDUSTRY

While the semiconductor industry continues to expand globally, including across DCO Member States, several key challenges persist that affect supply resilience, technological advancement, and ecosystem development.

Supply Chain Vulnerabilities and Geopolitical Tensions

The semiconductor industry faces unprecedented supply chain vulnerabilities exacerbated by geopolitical tensions as previously mentioned.

Geographic concentration means single points of failure threaten global technology systems, such as Taiwan producing the majority of advanced semiconductors creates existential risks for technology dependent economies. Natural disasters, pandemics, or military conflicts could halt production with global consequences.

The 2021 semiconductor shortage, triggered by pandemic disruptions, cost the automotive industry over $210 billion in lost revenues and highlighted systemic fragilities.[30] Building resilient supply chains requires massive investments in geographic diversification that may take decades to achieve.

Geopolitical competition increasingly weaponizes semiconductor dependencies with export controls being used by some nations to prevent adversaries from accessing advanced technologies but also fragment markets and reduce economies of scale.

Technology restrictions force countries to develop indigenous capabilities, duplicating research and reducing global innovation efficiency while subsidy competitions distort markets and risk overcapacity in certain segments while shortages persist in others.

Trust erosion between nations complicates international collaboration essential for addressing global challenges. The industry's technical complexity means that forced decoupling could set back technological progress by years or decades. Raw material dependencies add another vulnerability layer as rare earth elements essential for semiconductor manufacturing remain concentrated in few countries. China controls an estimated 60% of global rare earth mining and 85% of processing capacity and Russia supply 35% of global palladium used in semiconductors. On the other hand, Ukraine before the 2022 war produced 50% of neon gas required for lithography.[31]

Geographic concentration of critical materials creates leverage points that could disrupt entire supply chains and developing alternative sources requires years of exploration, environmental approvals, and infrastructure development. Material substitution research offers long term solutions but cannot address immediate vulnerabilities.

Capital Investment and Research Costs

Semiconductor manufacturing requires unprecedented capital investments that challenge even wealthy nations and large corporations.

A single advanced fabrication facility costs $20 to $30 billion, with additional billions required for ongoing operations and upgrades.[32,83] Equipment costs increase exponentially with each technology generation: EUV lithography machines cost €200 million each, and leading facilities require dozens.

Research and development expenses average 15% to 20% of revenues for leading companies, exceeding $15 billion annually for Intel and TSMC individually. These costs create overwhelming barriers for new entrants without government support or patient capital willing to accept decades long investment horizons[32, 83].

Returns on semiconductor investments remain highly uncertain given long development cycles and rapid technological change. Facilities take three to five years to construct and another two years to reach full production with technology advantages lasting only two to three years before competitors catch up. Market cycles create periods of overcapacity and losses even for efficient producers. Strategic considerations may override economic returns, as governments subsidise domestic production for supply chain security. These dynamic risks creating structural overcapacity that undermines industry profitability and innovation capacity.

Environmental Impact and Resource Consumption Challenges

The semiconductor industry faces environmental challenges due to its enormous demand for ultrapure water, which is essential for rinsing silicon chips during fabrication.

Producing ultrapure water requires intensive treatment processes, consuming roughly 1,400 to 1,600 gallons of municipal water to generate just 1,000 gallons of ultrapure water.

A single chip manufacturing facility can use up to 2 to 10 million gallons of ultrapure water daily, equivalent to the water usage of 33,000 US households.

This heavy reliance on scarce, high quality water resources puts additional pressure on already stressed water systems, creating a critical vulnerability for the rapidly growing semiconductor sector[33, 84] (Figure 4).

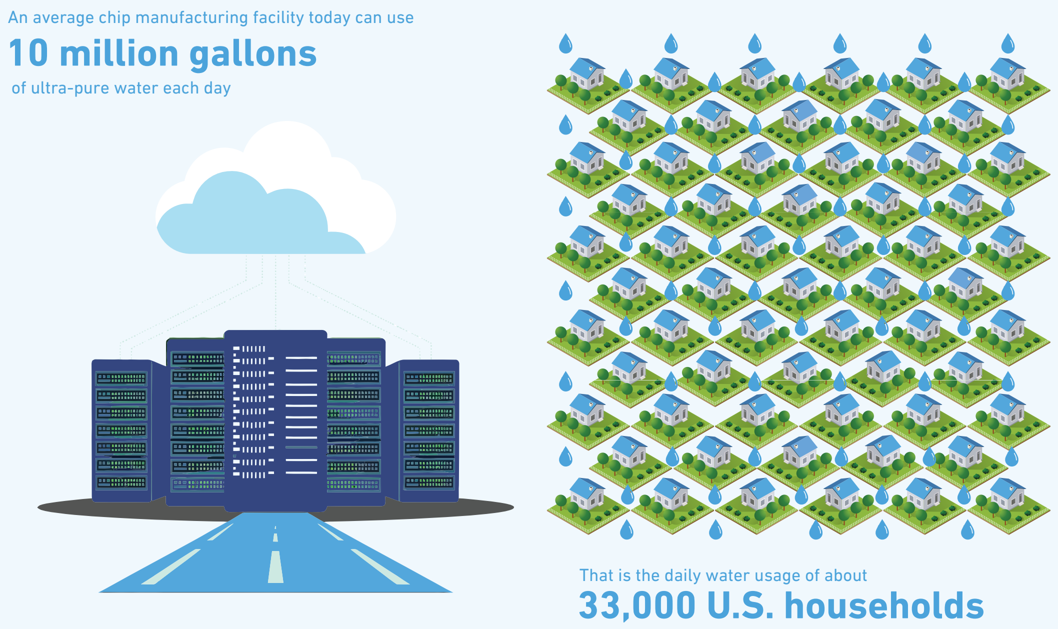


Figure 4:
Average Ultrapure Water Needs for a chip manufacturing facility

Beyond water consumption, semiconductor manufacturing generates significant greenhouse gas emissions and hazardous waste.

A typical fab consumes as much electricity as 50,000 homes, primarily for maintaining cleanroom environments and powering equipment, and even accounts for 1% of global electricity consumption, with this expected to double.[34,85]

Manufacturing processes use perfluorinated compounds with global warming potential thousands of times greater than carbon dioxide and chemical processing generates toxic waste requiring specialised treatment and disposal.

The industry's environmental footprint contradicts sustainability goals even as semiconductors enable green technologies so balancing environmental protection with technological advancement requires fundamental changes in manufacturing processes and materials, all of which comes at an even greater cost.

Skills Shortage and Talent Pipeline Gaps

The global semiconductor industry faces an acute talent shortage that threatens expansion plans and technological advancement. The United States alone needs 90,000 to 146,000 additional semiconductor workers by 2030, including engineers, technicians, and support roles, while current graduation rates produce only 65,000 qualified candidates.[35, 36]

Engineering programmes struggle to attract students to semiconductor specialisations perceived as less glamorous than software or artificial intelligence while experienced engineers are retiring faster than replacements enter the workforce.

Knowledge transfer from senior experts to younger engineers fails to keep pace with technological complexity and in the current environment, the talent gap creates a fundamental constraint on industry growth regardless of capital availability.

Educational systems have not adapted to semiconductor industry needs as universities often lack advanced fabrication facilities for practical training, being limited by the costs of fabs.

Curricula emphasise theoretical knowledge over industry relevant skills and few programmes integrate cross disciplinary expertise spanning electrical engineering, materials science, chemistry, and computer science required for modern semiconductor development.

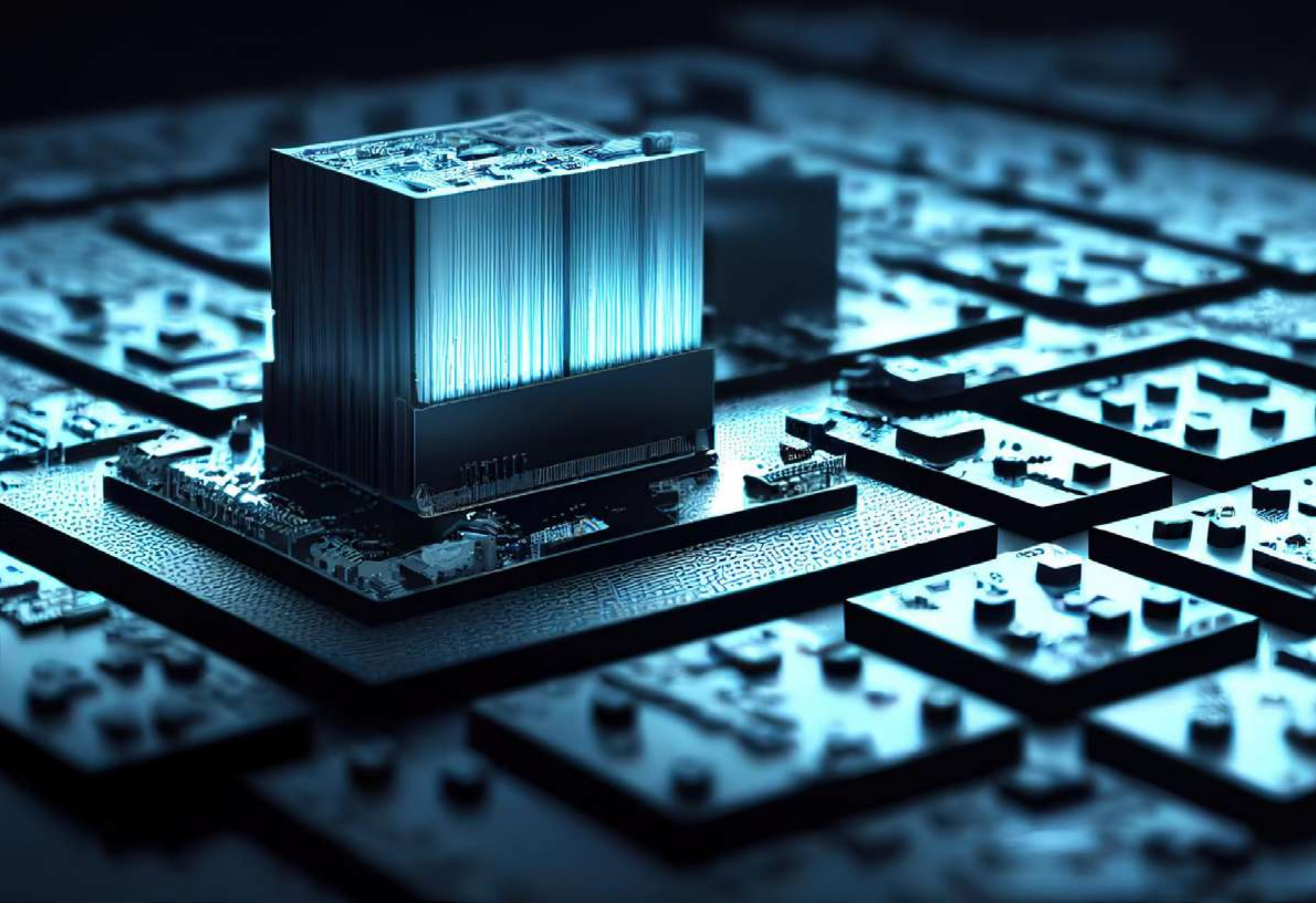
International competition for talent intensifies as every major economy pursues semiconductor strategies so countries must fundamentally reform technical education to develop competitive semiconductor workforces.

Lack of Participation from Developing Economies

Many developing economies remain underrepresented in semiconductor value chains, despite accounting for growing demand for electronic products and digital services. Significant capital requirements, technological complexity, and the advantages of established industry players can make entry into this sector challenging, particularly without sustained policy support, international partnerships, and long-term ecosystem development strategies. In some contexts, access to advanced equipment, specialized expertise, and certain technologies may also be constrained by regulatory, commercial, or intellectual property considerations.

This limited participation can contribute to continued technological dependence and restrict opportunities for higher-value industrial development. The concentration of semiconductor capabilities in a relatively small number of economies raises broader questions about inclusive global development and digital equality. Countries without semiconductor design or manufacturing capacity may face constraints in fully leveraging digital transformation and Industry 4.0 opportunities, as well as vulnerabilities related to supply disruptions, pricing volatility, and trade imbalances. Talent mobility trends may further widen capacity gaps if skilled professionals migrate toward established semiconductor hubs.

Addressing these challenges requires collaborative and balanced approaches. Developed nations and established semiconductor companies have an important role to play in facilitating technology transfer to developing economies through partnerships, joint ventures, capacity-building programs, and knowledge-sharing arrangements. At the same time, countries worldwide, including DCO Member States can explore negotiated technology transfer agreements that balance intellectual property protection with capability development, including through licensing models, co-development initiatives, and joint R&D partnerships. Such cooperative frameworks can help foster more diversified participation in semiconductor value chains while strengthening global resilience and innovation.



STRATEGIC RECOMMENDATIONS FOR STAKEHOLDERS

For Policymakers

Governments may develop and adopt comprehensive semiconductor strategies and policies balancing economic efficiency with strategic autonomy.

Investment incentives should target sustainable competitive advantages rather than attempting to replicate entire value chains so, therefore, focus areas may include specific technology nodes, application domains, or value chain segments where natural advantages exist.

Regional cooperation can achieve economies of scale impossible for individual nation, similar to the coordinated approach of the EU, despite implementation challenges, provides a model for regional semiconductor strategies.

Policies should address entire ecosystems including education, research, infrastructure, and regulatory frameworks rather than focusing solely on manufacturing capacity.

Policymakers may invest in semiconductor-focused education and training programs while fostering public–private–academic partnerships to establish specialized centres that build expertise in circuit design, embedded systems, IoT, and advanced technologies.

Such capacity building initiatives will align talent development with industry needs and ensure a future-ready workforce across the semiconductor value chain.

Environmental regulations must evolve to address semiconductor manufacturing's unique challenges while maintaining competitiveness.

Water recycling mandates could drive innovation in closed loop manufacturing systems or using carbon pricing mechanisms could account for semiconductors' enabling role in emissions reduction technologies.

Green semiconductor initiatives could create differentiation opportunities for environmentally conscious producers. International cooperation on environmental standards prevents regulatory arbitrage while protecting global commons. Sustainable semiconductor manufacturing is not optional given climate change imperatives.

For Businesses and Industry

Semiconductor companies must navigate increasing geopolitical complexity while maintaining technological competitiveness. Diversification strategies should reduce single point dependencies without sacrificing efficiency gains from specialisation.

Partnership approaches that share risks and knowledge can accelerate capability development while managing capital requirements. Open innovation models leveraging startups and research institutions complement internal development. Supply chain transparency enables risk identification and mitigation before disruptions occur.

Companies should engage proactively with governments on policy development rather than reacting to regulations.

Talent development requires industry leadership given educational system inertia. Companies should partner with universities on curriculum development, provide equipment for teaching laboratories, and offer extensive internship programmes.

Internal training programmes can bridge gaps between academic preparation and industry needs and it is essential for knowledge management systems to capture expertise from retiring engineers before institutional memory is lost.

Creating attractive career paths requires addressing work life balance, not just compensation, to compete with other technology sectors for talent.

For International Organisations

The International Organizations, including DCO may facilitate technology transfer agreements ensuring knowledge flows to emerging economies while protecting intellectual property rights. Investment frameworks must accommodate semiconductor industry characteristics, including decade long development cycles and high capital requirements.

By establishing a Semiconductor Cooperation, Member States can join forces to accelerate progress in this critical industry, leveraging shared strengths and collective action. Multilateral platforms for cooperation would further enable resource pooling for research projects beyond individual country capabilities, and DCO is well placed to facilitate this.

Technical assistance programmes could then help countries identify their comparative advantages within semiconductor value chains, whether in assembly, testing, design, or specialised applications. In addition, regional development funds could support shared infrastructure like design centres or testing facilities that individual counties cannot justify.

This is where international financial institutions could develop new instruments and financial vehicles to address the unique characteristics of semiconductor investment.

Digital Trade frameworks require updating to reflect semiconductors' strategic importance while preventing destructive subsidy races. Multilateral agreements, pushed by organisations like DCO, could establish subsidy disciplines preventing market distortion while allowing strategic investments, particularly amongst willing members.

Dispute resolution mechanisms should address digital technology restrictions and market access barriers, necessary in the growing international climate of isolationism. Rules of origin need modernisation given global value chain complexity.

Standards mutual recognition agreements facilitate trade while maintaining quality and security. Special and differential treatment provisions could enable developing country participation in semiconductor value chains. The World Trade Organisation and regional bodies must evolve frameworks balancing free trade principles with strategic autonomy imperatives.

For Educational Institutions

Educational institutions require fundamental reform to meet semiconductor industry demands. Universities must integrate semiconductor design, materials science, and advanced manufacturing into undergraduate curricula rather than treating these as postgraduate specialisations.

Industry partnerships should provide students with access to professional design tools and fabrication facilities, bridging the gap between academic theory and industrial practice.

International exchange programmes can build global networks while spreading expertise to emerging semiconductor regions. Research priorities must balance fundamental science with practical applications, ensuring innovations can transition from laboratory to commercial production within reasonable timeframes.

Complementing the strategic recommendations for policymakers, educational institutions may also integrate essential semiconductor skill sets into their programs, ensuring that curricula reflect the interdisciplinary nature of modern semiconductor technology by incorporating electrical engineering, computer science, materials science, chemistry, and physics.

Practical experience through internships and co-op programmes is essential given the gap between academic knowledge and industry requirements. Online education can democratise access to semiconductor expertise, though hands on laboratory experience remains irreplaceable.

Moreover, involving industry advisory boards directly into curriculum design will ensure curriculum relevance and facilitate graduate placement. Fundamentally, success requires sustained collaboration between academia and industry, else there will be a continued mismatch.

For Investment and Financial Communities

Investment strategies need adaptation to semiconductor sector characteristics. Patient capital models must accommodate fifteen-to-twenty-year horizons for advanced technology development to permit the timeframes required for semiconductor investment.

Risk sharing mechanisms between public and private sectors can enable investments in emerging technologies with uncertain commercial prospects but strategic importance, providing public support is reliable.

Regional investment funds pooling resources from multiple countries can achieve necessary scale while diversifying risk across participants.

Environmental and social governance criteria should incorporate semiconductor specific metrics including water efficiency, energy consumption, and supply chain transparency, particularly important for attracting international investment to new semiconductor regions.

Venture capital and private equity play crucial roles in semiconductor innovation but require different approaches than software investments. Semiconductor startups need hundreds of millions in funding compared to software companies' modest requirements, with development cycles spanning years rather than months, requiring patient capital.

Technical due diligence demands deep domain expertise rare in generalist investment firms and exit opportunities through acquisition may provide better returns than public offerings given industry consolidation.

Corporate venture capital from established semiconductor companies provides not just funding but critical technical expertise and market access.

The investment community must develop specialised semiconductor expertise to effectively allocate capital in this strategic sector and be reminded that research and development expenses represent investments in future competitiveness rather than a pure costs.

For the Digital Cooperation Organisation and Member States

The Digital Cooperation Organisation Members Sates should leverage their unique advantages to establish specialised roles within global semiconductor value chains.

For example, the Kingdom's of Saudi Arabia abundant capital, strategic location between Asia, Europe, and Africa, and commitment to economic diversification position it well for semiconductor investment.

Focus areas should align with national strengths: chip design for renewable energy systems supporting Saudi Arabia's solar ambitions, telecommunications semiconductors leveraging regional 5G leadership, and automotive chips supporting electric vehicle adoption. Partnership strategies should prioritise knowledge transfer agreements ensuring local capability development alongside foreign investment.

Collaboration among DCO Member States can achieve economies of scale that would be difficult for individual Member States to realize independently. Shared design centres reduce individual country investment requirements while providing access to expensive tools and expertise.

Joint talent development programmes leverage best practices across DCO Member States and coordinated investment strategies to prevent destructive competition while attracting global partners.

Common technical standards across DCO Member States will help facilitate digital trade and technology development, and research collaboration on applications relevant to regional needs, such as extreme temperature electronics for desert environments, creates differentiation opportunities.

The DCO may function as a platform for semiconductor cooperation rather than competition among its Member States. A core example of this is that Saudi Arabia's focus on chip design complements potential manufacturing in other members with lower labour costs. Coordinated strategies maximising individual country advantages while building regional capabilities offer the best path forward.

CONCLUSION AND FUTURE RESEARCH DIRECTION

The semiconductor industry stands at a critical juncture where technological advancement, geopolitical competition, and supply chain resilience intersect to shape the global digital economy. The concentration of advanced capabilities in a limited number of countries and companies creates both efficiencies and vulnerabilities requiring careful management. Saudi Arabia's emergence as a semiconductor leader within the DCO Member States through its National Semiconductor Hub demonstrates how countries can leverage their unique advantages to participate in this strategic industry. The Kingdom's focus on chip design, talent development, and international partnerships provides a model for other emerging economies seeking to build semiconductor capabilities.

The DCO has a vital role to play in enabling its Member States to collectively strengthen their position in the global semiconductor value chain. By facilitating knowledge sharing, coordinating investments, and promoting regional collaboration, the DCO can help members achieve together what would be impossible individually. The semiconductor strategies of Saudi Arabia and other Member States should be viewed not as competition but as complementary efforts building a stronger regional ecosystem. Success requires sustained commitment over decades, as semiconductor capability development cannot be achieved through short term initiatives.

Future research should examine specific opportunities for DCO Member States to specialise within semiconductor value chains based on their comparative advantages. Analysis of successful semiconductor ecosystem development in other regions can provide lessons for the Middle East and Africa. The role of emerging technologies like AI in accelerating semiconductor design deserves investigation but being mindful of environmental sustainability in semiconductor manufacturing will require breakthrough innovations that research institutions should prioritise. Workforce development models adapted to regional contexts need development and testing. Understanding how geopolitical dynamics affect technology transfer and investment flows can inform policy decisions.

The semiconductor industry's evolution will profoundly impact global economic development, technological progress, and geopolitical relations over coming decades. Countries worldwide and regions that successfully develop semiconductor capabilities will enjoy advantages in economic growth, technological sovereignty, and international influence, whereas those unable to build such capabilities risk marginalization in high-value economic sectors and dependence on foreign technologies and suppliers.

CONTRIBUTORS

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APPENDIX

List of Abbreviation, and their explanation

Abbreviation	Explanation
ATP	Assembly, Test and Packaging
CPU	Central Processing Unit
DCO	Digital Cooperation Organization
DRAM	Dynamic Random Access Memory
EU	European Union
EUV	Extreme Ultraviolet
GCC	Gulf Cooperation Council
GPU	Graphics Processing Unit (GPU)
HBKU	Hamad Bin Khalifa University
HCCC	Hellenic Chips Competence Centre
KACST	King Abdulaziz City for Science and Technology
KAUST	King Abdullah University of Science and Technology
KDIPA	Kuwait Direct Investment Promotion Authority
MoITT	Ministry of Information Technology and Telecommunication
MTCIT	Ministry of Transport, Communications & Information Technology
NAND	NOT AND Flash
NITDA	National Information Technology Development Agency’sTechnology
PIF	Public Investment Fund

APPENDIX

List of Abbreviation, and their explanation

Abbreviation	Explanation
PSA	Pakistan Semiconductor Association
PSUT	Princess Sumaya University for Technology
QSTP	Qatar Science & Technology Park
R&D	Research and Development
SEZAD	Special Economic Zones, Duqm
TSMC	Taiwan Semiconductor Manufacturing Company
US	United States
VLSI	very large-scale integration
ICT	Information and Communications Technology
KISR	Kuwait Institute for Scientific Research
SCOE	Semiconductor Centre of Excellence

Digital Cooperation Organization

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