Microprocessors

A Partnership for Innovation: From “Made in Mexico” to “Designed in North America”

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Introduction: Microprocessors at the heart of a global paradigm shift

> *We live in a computerized world. I can't do anything anywhere. I can't get information—I can't be fed—I can't amuse myself—I can't pay for anything, or check on anything, or plain do anything—without using a computer*
>
> *A Perfect Fit,* Isaac Asimov, 1981

An integrated circuit, microprocessor, chip, or whatever we call that tiny slab of silicon or germanium that conducts electrical signals is the protagonist of a new global geopolitical and economic battle. These devices in virtually every electronic device will define the 21st-century rivalry between Beijing and Washington. This rivalry will not be won with barrels of oil or steel but with computing power and, inevitably, microprocessors.

One of the most critical fronts in this battle is Taipei, Taiwan's capital. In this nation, it is not unusual for a Category 4 hurricane and a drill for potential air attacks from its neighboring country to occur in the same week.

In this beautiful—and dangerous—one-fifth of the world's microprocessors and nearly 90% of the most advanced processors are produced, with less than 10 nanometers between connections.

Changing weather conditions and recent geopolitical ups and downs have caused buyers of this new gold in the form of iridescent wafers to look for alternative locations to produce these tiny components.

"If you had asked me three years ago, I would not have been able to offer an opinion on the Mexico-United States-Canada Treaty (USMCA), but today I am convinced that the countries that make up the Treaty are a great area of opportunity for Taiwanese business," says Richard Tsu Chin Lee, president of the Taiwan Electrical and Electronic Manufacturers' Association (TEEMA), created in 1948 to promote the semiconductor industry in the country.

The double-headed buffalo in the lobby of TEEMA's downtown Taipei offices seems to symbolize the association's ability to see the past and the future. Its members are electronics and microprocessor manufacturers who, in the wake of the COVID-19 pandemic and a growing rivalry between the United States and China, are looking for new regions to expand their operations.

TEEMA is active in Southeast Asia, especially Vietnam; in Europe, it collaborates with the Czech Republic, but the region that draws the association's attention is North America, with some 500 million inhabitants connected by a trade agreement and the border between the United States and Mexico. Here, several of its members are exploring the business potential,

such as the Taiwan Semiconductors Manufacturing Company (TSMC), which is building a factory in Arizona. Foxconn and other Taiwanese companies already have operations on the Mexican side, in Ciudad Juárez, and have announced that they will open new plants in Jalisco.

The desire to keep microprocessor production in the space of allies and away from potential enemies has already been translated into state policy in Mexico and our neighbor to the north.

In August 2022, the United States government published the CHIPS and Science Act, which created a pool of incentives for local research, development, and manufacturing of microprocessors worth $52.7 billion. As part of this program, the U.S. government created the International Fund for Innovation and Technological Security, which, with a budget of 500 million dollars, seeks to promote the development of the semiconductor industry in friendly countries such as Costa Rica, Panama, and Mexico.

The Ministry of Economy in Mexico has not stood by and, in 2022, published a document entitled “Towards an Industrial Policy,” describing the need to increase the participation of Mexican companies in global microprocessor production chains. Meanwhile, in her inaugural speech in Mexico City’s Zócalo after her inauguration on December 1, President Claudia Sheinbaum announced the creation of the Technological Development Program for Innovation to develop “technology made in Mexico by Mexicans.”

More recently, the electronics industry, represented by the National Chamber of the Electronic, Telecommunications, and Information Technology Industry (Canieti), announced on October 18 a Master Plan 2024-2030 that seeks to double the country’s semiconductor industry’s activity.

The establishment of microprocessor design and manufacturing operations in Mexico to supply the Western Hemisphere market represents potential business opportunities for Mexico, with a possible market of between eight and ten billion dollars per year. For the country, this means almost one percentage point of Gross Domestic Product with high-end jobs in states linked to the automotive manufacturing chain that requires intensive use of microprocessors in internal combustion or electric vehicles.

According to Miguel Angel Olea, managing partner at asset management firm SouthLight Capital, microprocessor manufacturing operations take three to five years to set up. This means that, towards the end of the decade, companies from the United States and Taiwan that decide to set up in Mexico could begin to see the first processors leave their doors for the domestic and North American markets and wherever else they are consumed.

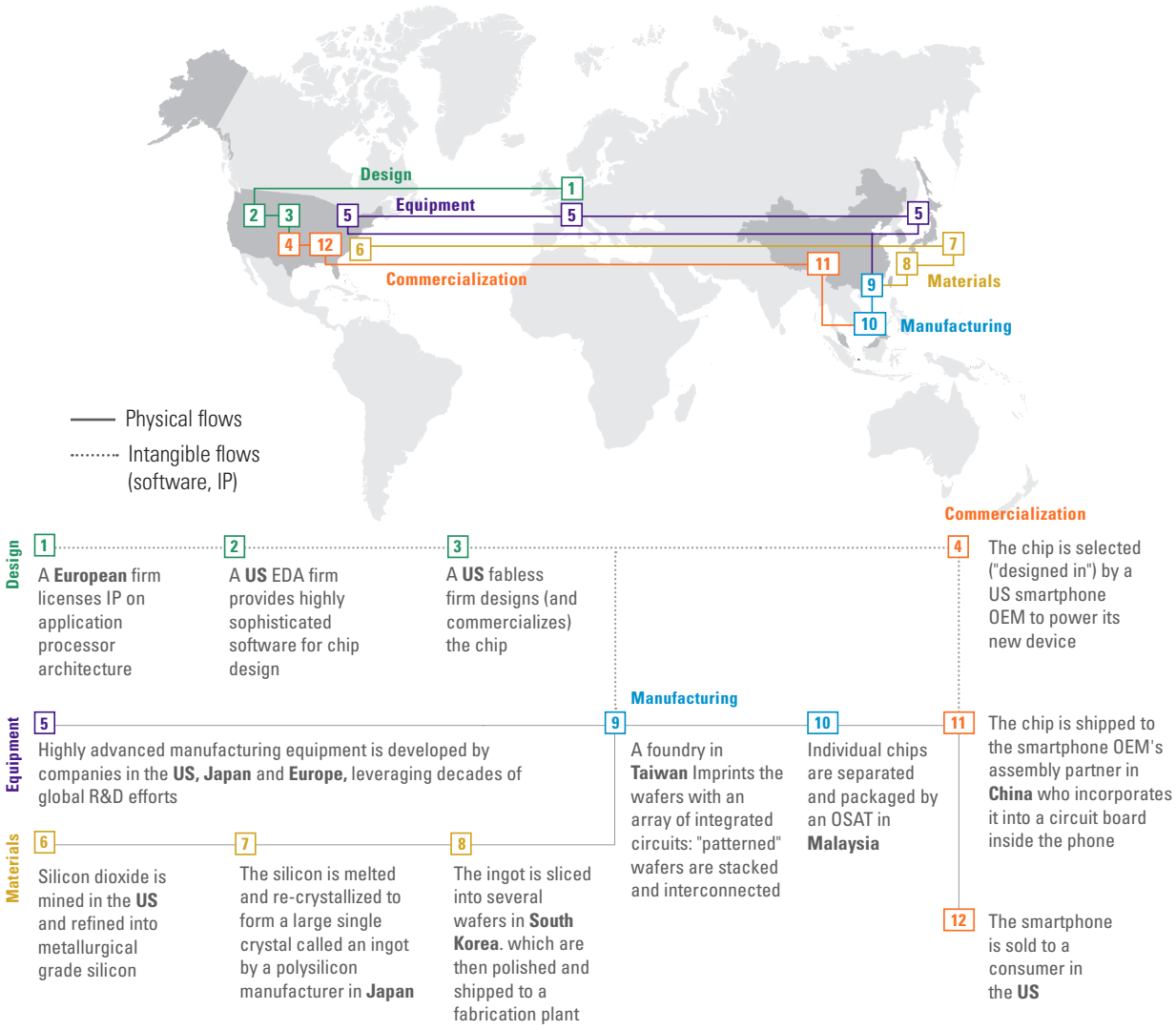
However, one question remains: How can Mexico exploit this opportunity? This is a significant challenge as nations such as Costa Rica and Colombia seek to achieve objectives similar to those of Mexico. These countries have industrial policies in place, but they also have electricity, water, talent, training, and readiness.

01 | Technology as a catalyst for supply chain integration

An X-ray of the global microprocessor industry

The multinational chip supply chain is perhaps one of the best examples of economic globalization. It relies on the movement of components and products across regions thousands of miles apart, all of which contribute to the processes of design, production, assembly, and distribution.

The Global Journey of a Smartphone Processor

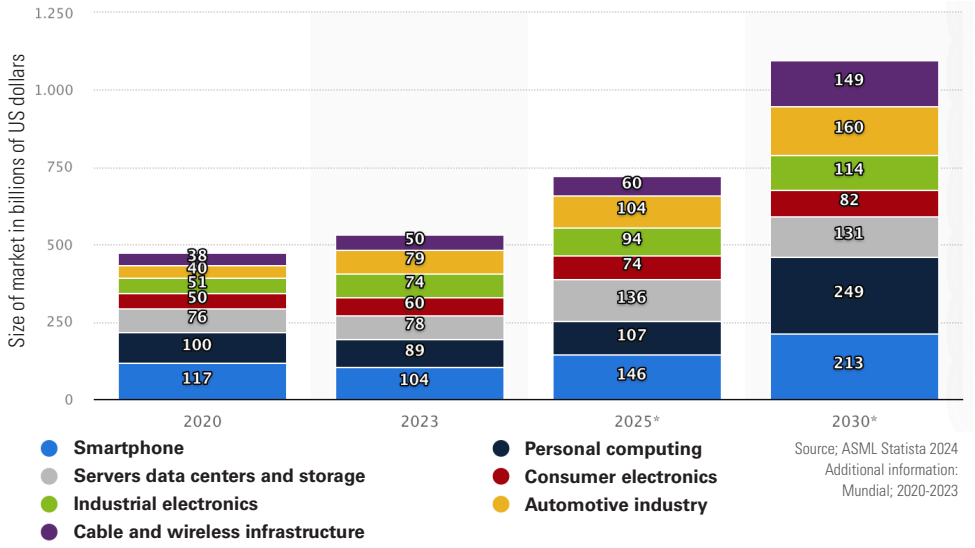


Source: Boston Consulting Group and Semiconductor Industry Association. *Strengthening the Global Semiconductor Supply Chain in an Uncertain Era.* (2021). Available at: https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf

The microprocessor industry is one of the main drivers of innovation and disruption globally due to its key role in a multitude of value chains for sectors such as the manufacturing of motor vehicles, smartphones, computing tablets, servers for storage and data processing centers, electronic devices for consumer and industrial markets, among many others.

By 2023, global semiconductor sales will exceed $500 billion, and the market is expected to grow, with projections that it could exceed $1 trillion by 2030. This would represent a compound annual growth rate of approximately 10% over the next seven years and reflects the growing demand for semiconductors in various technological applications.

Size of global semiconductor market in 2020 and 2025, by destination of use (in billions of dollars)



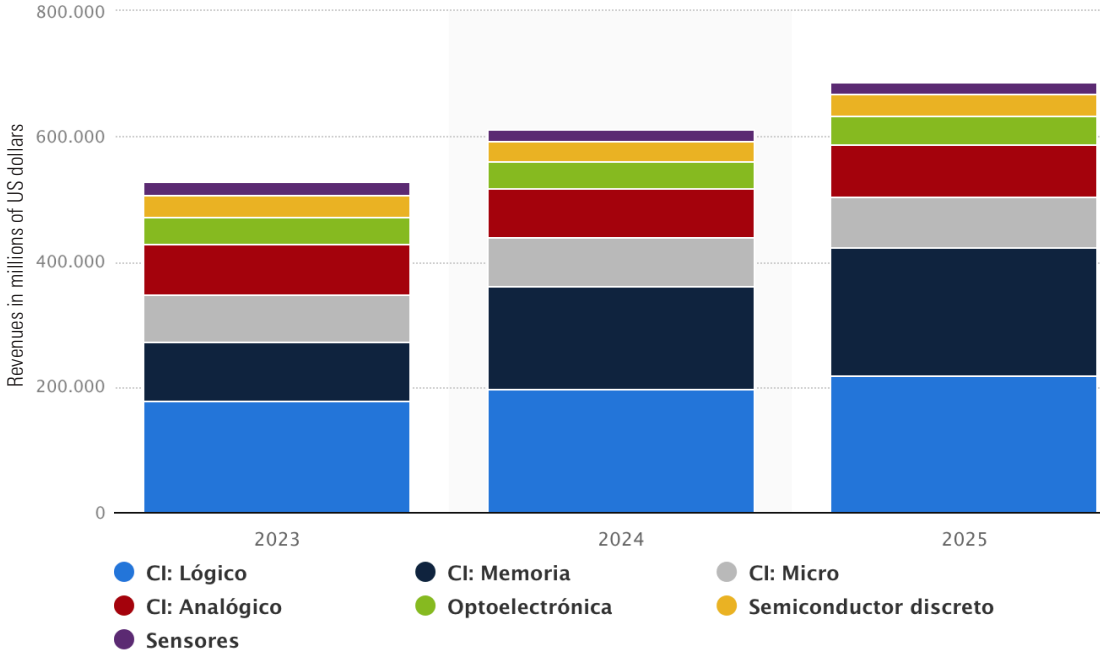
Source: Advanced Semiconductor Materials Lithography. *Global semiconductor market size in 2020 and 2030 by destination of use.* (2024). Available at: https://es-statista-com.ieselib.idm.oclc.org/estadisticas/1270887/tamano-global-del-mercado-de-semiconductores-segun-destino/

In addition to electronic devices, the microprocessor-producing sector will experience significant business opportunities in emerging sectors through its integration into processing units used to enable computing networks that operate LARGE LANGUAGE MODELS (LLMs), which serve both for pattern detection in large volumes of data and for use in generative pre-trained transformers like the now famous ChatGPT.

Another area of growth for semiconductors is the automotive sector, where manufacturers are integrating an increasing number of processing units into their vehicles, and factories are becoming increasingly connected and demanding data processing.

Microprocessors embedded in integrated circuits that manufacture central processing and data storage units, household appliances, mobile devices, and vehicle components account for around 85% of the total market, worth more than $450 billion. These verticals lead global revenue with around 30% of the total market.

Another high-impact category is optoelectronic semiconductors, such as lasers and photodetectors, to convert electrical signals into optical signals used in consumer, industrial, and military products and fiber optic networks, which are increasingly common in fixed telecommunications networks.



Source: Seeking Alpha. *Global semiconductor industry revenue forecast for 2023 and 2025.* (2024). Available at: https://es-statista-com.ieselib.idm.oclc.org/estadisticas/1409573/semiconductores-facturacion-mundial-por-tipo-de-producto/

Some underlying factors responsible for this rapid growth in the microprocessor sector include:

- **The adoption of emerging technologies, such as the massive deployment of fifth-generation telecommunications networks (5G), the growing incorporation of processors in industrial devices (Internet of Things, IoT), artificial intelligence (AI) systems, and autonomous vehicles, increases** the global demand for semiconductors.
- The **transformation** and **digitalization of industries** such as electronics, automotive, telecommunications, and service sectors such as health drive demand for devices to obtain and process data.
- The increase in investments in **research and development** (R&D) as a driver of innovation in the design and manufacture of products for a growing number of applications and industries.
- The **diversification** and **strengthening** of semiconductor **supply chains** help mitigate the risks inherent in the concentration of production in Asia.
- **Macroeconomic factors** driven by the increasing digitalization of global economies, the urbanization of the world’s population, the slowdown in population growth, and the increase in the proportion of elderly people.

The major players in the semiconductor market can be classified into four segments.

The **first segment** belongs to Integrated Device Manufacturers (IDM), companies that design, manufacture, and market integrated circuit products. This category includes Samsung, Intel, SK Hynix, Micron, Infineon, Texas Instruments, STMicroelectronics, and NXP Semiconductor players.

The **second segment** comprises semiconductor manufacturers that cannot manufacture their silicon wafers but specialize in the design and commercialization of chips, **companies known as *fabless***. Companies such as Nvidia, Qualcomm, Broadcom, AMD, and MediaTek stand out here.

The **third segment** belongs to the **semiconductor foundries**, which are factories that specialize in manufacturing chips and integrated circuits. Players in this category include TSMC, Samsung, GlobalFoundries, UMC, and SMIC.

A **fourth segment** belongs to the companies specializing in assembly, testing, and packaging (ATP). Companies such as ASE Group, Amkor Technology, JCET, and Powertech Technology dominate this last segment.[1]

The risks of technological supply chain disruption

Chip manufacturing is perhaps one of the most complex industrial activities. The Product Complexity Index (PCI) developed by Harvard University indicates that this is the fifth most sophisticated of all economic activities. As a result, the semiconductor manufacturing industry is an interconnected ecosystem with different countries specializing in various processes in the supply chain.

The United States and Europe lead the design phase with companies like Qualcomm and Nvidia, which are known for their cutting-edge chip architectures and intellectual property. However, the focus lies in Asia, where countries like Taiwan, South Korea, China, and Japan dominate the market in manufacturing, assembly, testing, and assembly.

These nations have invested significantly in building state-of-the-art manufacturing facilities and developing a robust supply chain ecosystem, establishing themselves as indispensable players in the global semiconductor industry. Here, we can highlight Taiwan, home of TSMC, the largest semiconductor foundry with a market share greater than 50% and the leading supplier for companies such as Apple, AMD, and Nvidia.[2]

The microprocessor industry relies on expertise that cannot be easily replicated. Sophisticated manufacturing facilities take years and billions of dollars in investment to build and have unique specializations spanning Asia, North America, and Europe. However, this extensive and delicate value chain has been subject to situations that reveal its fragility in recent years.

The surge in demand for electronic devices for millions of people working from home due to the COVID-19 pandemic strained the production capacities of the microprocessor industry, combined

with the lockdowns imposed on Asian and European countries between 2020 and 2021, caused a significant labor shortage that led to the underutilization or closure of factories and an increase in import prices of raw materials for microprocessor manufacturing around the world.

According to data from the United States Bureau of Labor Statistics, during the period December 2020-2023, the import price index for components for microprocessor manufacturing in the United States increased by 3.4%, driven by the saturation of supply chains and the increase in lead times of global raw material suppliers.[3]

The drought that hit Taiwan in 2021 and Russia’s invasion of Ukraine the following year made sourcing processes for the microprocessor industry more difficult.

Global supply chains that supply the microprocessor industry provide access to cheap labor, resulting in low production costs. However, disadvantages such as long lead times, low operational flexibility, instability in supply chains, low-quality standards, and trade and tariff barriers have driven the growing trend of bringing production and manufacturing centers closer to local demand centers.

In response to this challenge, companies in the sector are exploring remedial measures by opening new plants or relocating existing facilities to other countries. Taiwanese company Foxconn has been one of those seeking to approach the US market through strategies such as the one announced in October 2024 with the construction in Mexico of a plant to assemble GB200 model chips, specialized in artificial intelligence applications, for the Californian company Nvidia Corporation.

Multipolarity in supply chains, a view from the front row

Dinners in Davos, the small Swiss town where the World Economic Forum is held annually, are a time for conversations that break with protocol and are usually more profound than the speeches given hours earlier. Confidentiality rules do not allow the identification of the Chinese central bank official who mentioned at one such dinner: “In the 1970s, we were afraid of the wolf; in the 1980s and 1990s, when we were studying in the United States, we started dancing with the wolf and now, in the 21st century, what you have to understand is that China wants to be the wolf.”

In the coming decades, the rivalry between the United States of America and the People’s Republic of China may move from a latent conflict to a heated confrontation. Globalization, once considered unavoidable at the end of the last century, was abruptly interrupted by the dislocation of supply chains caused by the COVID-19 pandemic in 2020. COVID has clarified that regionalization, not globalization, will be the game’s new name after the first quarter of the new century.

All those interviewed for this work maintained that it is impossible to expect national manufacturing from A to Z. Total import substitution and self-sufficiency are no longer

feasible. Still, they also qualified the idea of the 1990s, fostered by the fall of the Berlin Wall and the Washington Consensus, where supply chains can span the entire globe. It does not matter where the parts are produced as long as the principle of "just in time" assembly is respected.

Shannon K. O'Neill claims in her book titled The Globalization Myth: Why Regions Matter that regional supply chains have lower greenhouse gas emissions than transregional flows, reducing costs and creating opportunities in the labor market. For O'Neill, the future of the North American region lies in specialization within the nations that make up the USMCA, not only for commercial efficiency but, as other authors and interviewees in both Taiwan and Mexico said, for a principle of national security.

Moreover, using a microprocessor in a commercial hair dryer is not the same as using one in a ship like the USS Mustin patrolling the South Sea Strait, as described by Chris Miller in his indispensable book Chip War, in which he documents the fight over the world's most important technology: microprocessors.

Rhetoric aside, regionalization is a reality of the 21st century. Adhering to this logic and aligning industrial policies in North America makes perfect sense economically and politically.

02 | Towards *"Designed in North America"*

The CHIPS Act, a trigger for a new global industrial policy

In August 2022, US President Joe Biden announced the CHIPS and Science Act, a public policy and government investment tool to revitalize the United States' chip production capacity. This legislation assigns **52.7 billion.**[4] dollars in incentives for chip research and production activities to reduce its dependence on Asia, especially Taiwan and China. This movement triggered government reactions in all the regions, as summarized below.

North America

Canada has already begun its journey to boost the production and supply of microprocessors in 2021, investing around 460 million dollars[5] to date. Its most recent investment was $43 million in April 2024 for IBM Canada projects and the strengthening of the MiQro Collaborative Innovation Center, which is dedicated to expanding semiconductor production.

On June 5, the Mexican government published the Collaboration Agreement in the Official Gazette to Promote the Semiconductor Industry's Development. This effort builds on previous policies, such as the National Development Plan 2019-2024, which established as a priority encouraging private investment, both national and foreign, to reactivate the economy, create well-paid jobs, and strengthen the competitiveness of industry in Mexico.

In July last year, the federal government launched the One-Stop Shop for Investors (VUIMX) to facilitate investor interaction, streamline procedures, and promote sectors with high potential for economic growth, such as semiconductors. The agreement was formalized to coordinate the inter-institutional efforts necessary to develop a robust and competitive semiconductor industry in the country. The VUIMX provides various services, including tax services, immigration services, business establishment, trademark and invention registration, real estate acquisition, and foreign trade promotion programs.

President Claudia Sheinbaum explicitly presented in February 2025 a project named 'Kutsari' to work with the private sector to get Mexico to be an actor in the microprocessing manufacturing supply chain by 2026.

In addition to domestic policies, the three countries in the North American region have developed joint initiatives. In 2023, authorities in Canada, the United States, and Mexico issued a joint statement that committed to strengthening regional supply chains in key future industries such as semiconductors and promoting strategic investments.[6]

Central and South America

Some of the region's largest economies have responded by developing the infrastructure capabilities needed for chip production. Brazil, Colombia, and Costa Rica are among these pioneering nations.

Brazilian President Luis Inácio Lula da Silva and Minister Geraldo Alckmin presented Mission 4 of the New Industry Brazil (NIB) in September, where they committed BRL 186.6 billion in initial investments for chip manufacturing, robotics, telecommunications, and cloud computing. NIB aims to digitize half of Brazilian industrial companies by 2033, with an intermediate target of 25% of companies digitized by 2026. In addition, the government announced a program to encourage domestic semiconductor production in September, with $214 million annually until 2026.[7]

In July, Colombia announced the draft Law on Chips, which seeks to boost the electronics and semiconductor industry in the country to strengthen technological sovereignty and economic growth. The project's pillars are to foster technological entrepreneurship, promote innovation, and train human talent in STEM areas (science, technology, engineering, and mathematics). As an additional measure, the proposal seeks to facilitate customs processes, provide tax benefits, and promote the country abroad to secure investments.[8]

Costa Rica is a pioneer in developing semiconductors in Latin America and perhaps one of the best examples of this industry's ups and downs. The microprocessor company Intel established a factory here in the late 1990s, but it ceased operations in 2014, and its operations moved to China, Vietnam, and Malaysia.

A decade later, Costa Rica is seeking to position itself as a source of chips for the United States. In March, President Rodrigo Chaves launched a plan to become a regional hub for the semiconductor industry. The plan encompasses four pillars: talent development, modernization of incentives, attracting investment, and a regulatory framework to attract foreign direct investment.[9]

Intel plays a key role in the country, having invested 1.2 billion dollars in it. Costa Rica is expected to graduate thousands of professionals annually in production processes related to the microprocessor industry.[10]

Europe

On the other side of the Atlantic Ocean, the European Union’s Chips Act came into force in September last year to counter vulnerabilities in supply chains and dependence on semiconductor suppliers in East Asia.

Regional regulation consists of three pillars: increasing infrastructure and technological capacity, attracting investors to ensure production, and developing an emergency response mechanism. To support this industrial policy, the European Union will invest 43 billion euros, aiming to possess 20% of the chip production market by 2030, mainly benefiting Slovakia and Poland.[11].

Slovakia, one of the leading manufacturing countries in the EU—30% of its GDP comes from industrial sectors—defined a roadmap aligned with the general objectives of the European Union in the digital transformation for 2030[12] and announced in September the signing of a memorandum of understanding with Taiwan to jointly develop semiconductor technology.

Poland also plays a leading role in the European Union’s achievement of the Chips Act objectives. In 2023, Intel announced an investment of 4.6 billion euros to build a semiconductor assembly and testing plant in Wrocław that is expected to cover the anticipated demand for assembly and testing capacity by 2027.[13]

Asia-Pacific

Two countries in the region that have been far from the focus on processor supply chains have defined strategies to position themselves through public policies and in collaboration with the United States government.

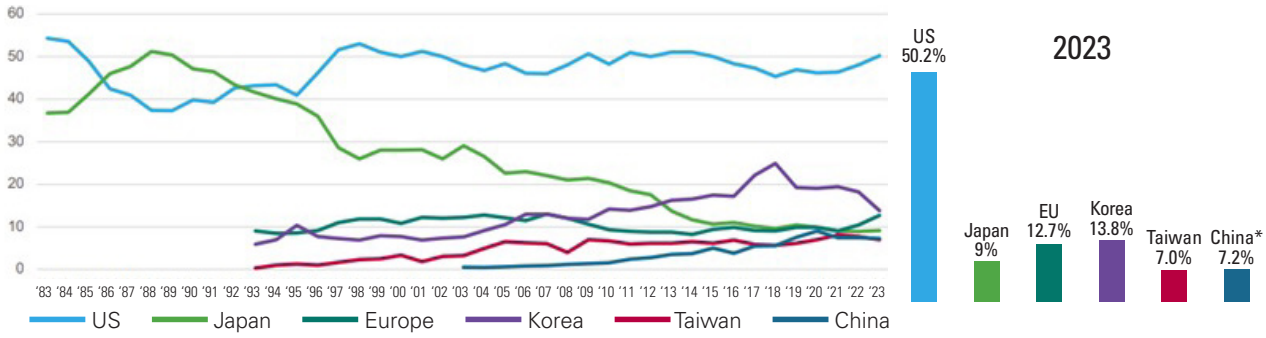
Vietnam outlined a long-term strategy for developing its semiconductor industry in September 2023, signed by Prime Minister Pham Minh. The document aims to make Vietnam a global leader in microprocessors by 2050. In line with the national strategy, the government announced the Comprehensive Strategic Partnership between the United States and Vietnam the same month, which President Joe Biden and General Secretary of the Communist Party of Vietnam Nguyen Phu Trong announced.

Bilateral cooperation between the two countries has expanded in several areas since then, such as using the International Fund for Security and Technological Innovation created by the CHIPS and Science Act of the United States.[14]

Indonesia is another regional player seeking to position itself in the microprocessor manufacturing sector following the announcement made in July by José W. Fernández, the US Under Secretary of State for Economic Growth, Energy and Environment, who indicated that the United States could support the Asian nation with educational opportunities, investments from American semiconductor companies and exchange programs, sponsored by the CHIPS and Science Act.[15]

Mexico, a keystone of the North American high-tech supply chain

2023, American producers will account for more than 50% of global microprocessor sales. Additionally, American microprocessor companies maintain leadership in research, development, design, and process technology.



Source: US Mexico Foundation. *Semiconductors The Next Near-shoring Frontier.* (2024). Available at: https://usmf.squarespace.com/s/Semiconductors-101.pdf

The United States sells but does not produce many chips; more than 80% of production is concentrated in Taiwan (65%), South Korea (15%), and China (7%). This dependence was one of the factors that triggered the shortage of microprocessors during the COVID-19 pandemic.

To stimulate the development of its domestic microprocessor industry, the United States government has created several budgetary funds, detailed below:

- **39 billion dollars** to encourage semiconductor manufacturing in the United States.
- **13.2 billion dollars** for research, development, and workforce training.
- **500 billion dollars** over 5 years, starting in 2023 ($100 million), to strengthen semiconductor supply chains and improve information and communications technology security through the International Technology Security and Innovation (ITSI) Fund.

The first phase of the partnership consists of assessing the infrastructure, microprocessor production ecosystem, and regulatory framework of each candidate country. Based on the analysis, roadmaps are defined with initiatives to be deployed jointly.

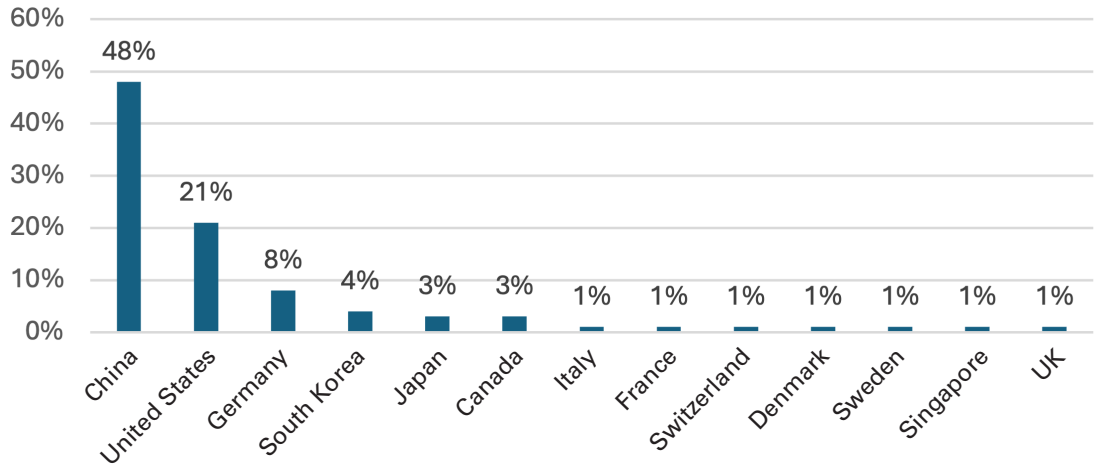
In Mexico, the country’s potential to expand its semiconductor industry is emphasized. This would benefit both nations based on existing cooperation under the High-Level Economic Dialogue and the North American Leaders’ Summit process.

The Partnership for Economic Prosperity in the Americas will support ongoing work to strengthen regional competitiveness in semiconductors, including workforce development.

Mexico has a strategic geographical position to become the main supplier of semiconductors. The northern neighbor represents 21% of *nearshoring* transactions, and as the *high-tech* market grows, growth in US share is expected. The configuration of the automotive market and the burgeoning potential of electric vehicles enhance Mexico’s priority status. Today, there are 37 automotive plants in 12 states of the country, and all need a growing number of microprocessors. According to industry experts, it is estimated that an internal combustion vehicle requires around 1,500 chips, while an electric vehicle requires more than 4,000 chips.

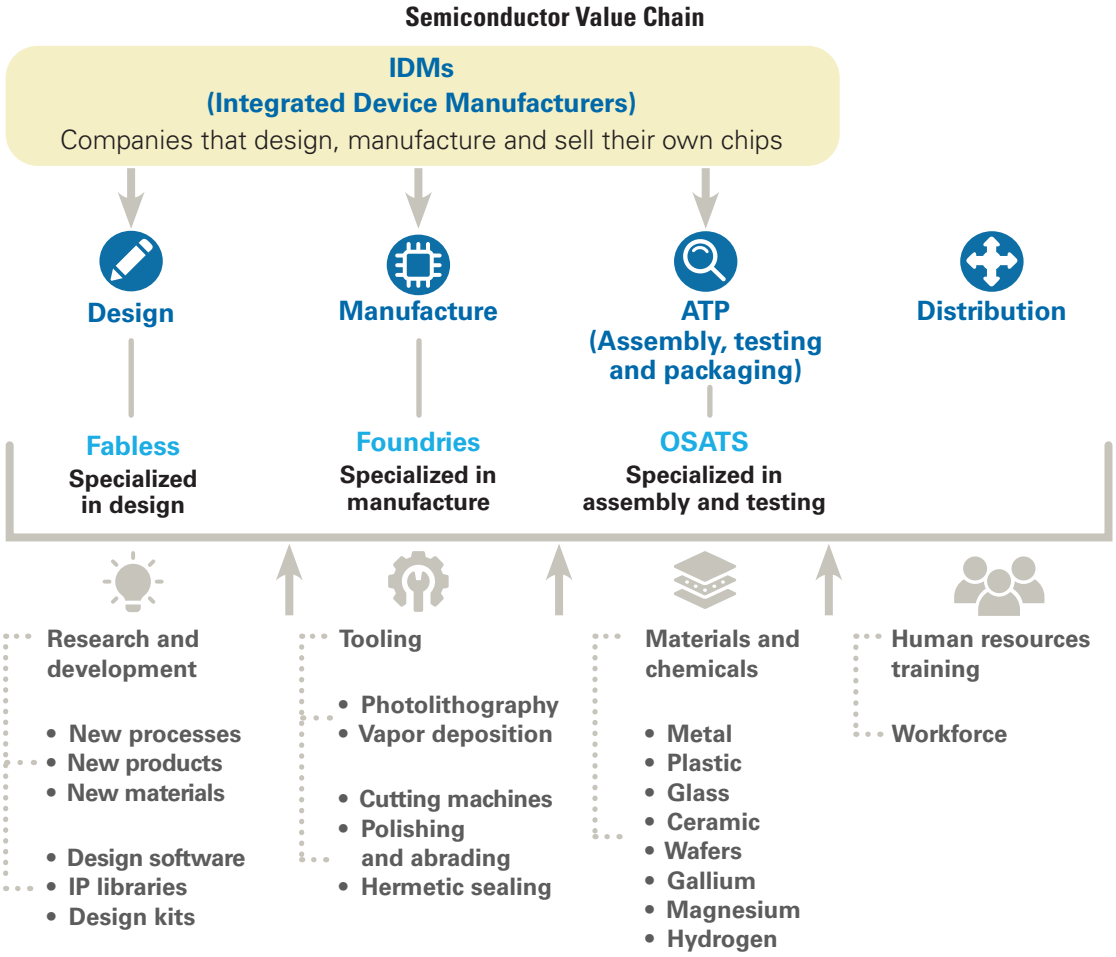
However, the process of evolving the microprocessor supply chain in the country will be gradual due to the challenges of developing new industries and integrating new geographies into supply chains.

Countries of origin of demand for nearshoring (2019-1H 2024)



Source: Prepared by the authors with information from CBRE Research

As mentioned earlier, the semiconductor industry’s value chain can be segmented into three specific activities: design and intellectual property, semiconductor manufacturing (front end), and semiconductor assembly, testing, and packaging activities (back end).



Source: Mexico-United States Science Foundation and United States Agency for International Development. *Route Map: Opportunities for Semiconductor Nearshoring in Mexico.* (2024). Available at: https://fumec.org/semiconductors.

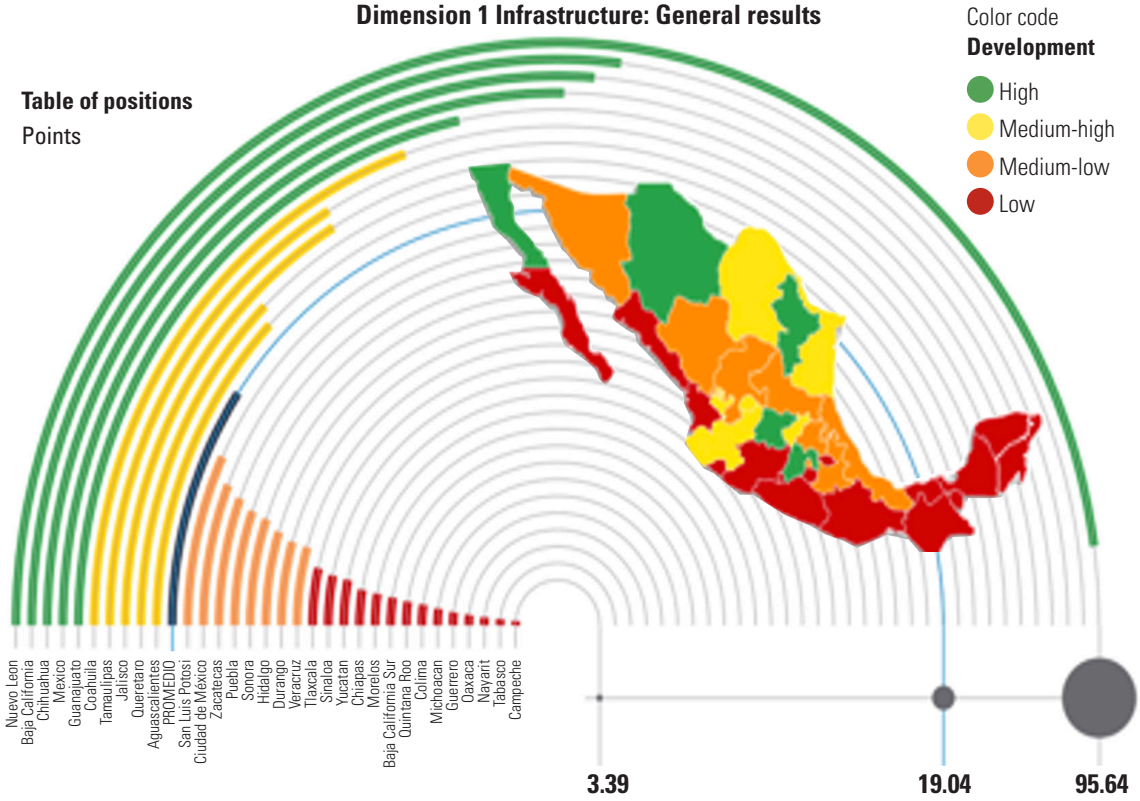
For Mexico, companies are identified as having a presence in the **backend** of the microprocessor value chain. These activities require less capital investment than at the **front end**, which involves the manufacturing and design of the chips themselves.

Compared to Asian countries, Mexico does not yet have a significant presence in the frontend segment. However, with the support of the United States and recent collaborations in research and development, Mexico could increase its participation in this part of the value chain since it has already developed the capacity to join the semiconductor production chain.

Some states in the country already have an investment platform dedicated to industrial development. **Nuevo León** leads in industrial warehouse inventory, with 14.5 million square meters, and reports the highest level of growth in industrial construction. Other states with rapid growth in industrial space include **Jalisco**—where the new Foxconn investment is located—**Aguascalientes**, **Chihuahua**, **Baja California**, and **Coahuila**.

For its part, **Mexico City**, **New Leon**, **Baja California**, and **Jalisco** stand out for having the best fixed broadband download speeds, while the ports with the greatest capacity for container cargo traffic are **Manzanillo**, **Lazaro Cardenas**, and **Veracruz**, benefiting different states depending on their proximity.

Industrial states such as **Chihuahua**, **Coahuila**, and **New Leon** compensate for their lack of maritime access with their land connections to the **USA**, the main destination for their industrial exports.[16]



Source: FINSA. *Industrial Development Index*. (2024). Available at: https://www.finsa.net/indicedesarrolloindustrial/

Monterrey has emerged as the market with the highest demand for space for nearshoring activities, registering 300,000 square meters in the first half of 2024. The markets along the northern border account for 77% of the nation’s gross demand for manufacturing space.

Mexico can create and take advantage of mechanisms that position the country within all the links of the value chain, according to **USAID and FUMEC,17** which include:

1. **University research centers** are dedicated to advanced research, collaborating with leading industry partners and offering specialized educational programs.
2. **Public-private partnerships** unite collaborative efforts between the government, the private sector, and academia.
3. **Government-funded research and development initiatives** promote research and development (R&D) initiatives in microprocessor technologies and their applications.

4. **Industrial consortia** help establish norms and standards, promote innovation and learning, and promote participation in domestic and international forums. In Mexico, the body that could oversee this process is the National Chamber of the Electronics, Telecommunications, and Information Technology Industry.
5. **Industrial clusters** bring together similar companies in a geographic area and share markets, technologies, inputs, and labor, often sharing the same value chain.

Mexico is in the process of launching a national master plan to boost the microprocessor industry. At the same time, some states have already made progress in this process, such as Aguascalientes, Baja California, Chihuahua, Querétaro, and Tamaulipas. Jalisco even created a public policy known as the Jalisco Tech Hub Act in 2022 to consolidate the state as a leader in innovation, technology, and high-value-added manufacturing with a strategy based on three pillars:

1. **Talent development**: educational initiatives to train and certify students and professionals in technological skills, such as semiconductor design and other STEM areas. It is expected to train more than 60,000 students annually and certify 3,000 professionals in key competencies.
2. **Government incentives**: Provide tax incentives and support small and medium-sized businesses in their adaptation to Industry 4.0
3. **Territorial reserve**: 139.7 hectares of land with commercial value will be allocated to attract strategic technology companies, favoring the development of industrial and technological hubs in the state.

Initiatives such as those in Jalisco represent the first step towards placing Mexico in the path of world powers in the semiconductor value chain, and time is running out. According to **experts, there is a 5-to-10-year window to capitalize on these opportunities,** and expansion is expected to favor states that already have infrastructure or industrial clusters.

Additionally, companies are expected to appear to carry out activities in new **areas of specialization** beyond assembly, testing, and manufacturing processes, such as chip design, software creation, and specialized materials.

While AI automates jobs in numerous sectors, the **semiconductor industry** creates highly specialized and well-paid jobs. This is crucial for Mexico, as it offers an alternative to job sectors that could be displaced by automation.

Trade organizations such as the National Chamber of the Electronics, Telecommunications, and Information Technology Industry also develop their own strategies, such as the Master Plan for the Development of Semiconductors 2024-2030, which proposes an investment of at least 10 billion dollars to boost manufacturing, design, research and development, testing, and assembly of microprocessors.

04 | Levers for regional transformation

The urgency of addressing challenges for industrial development in Mexico

In November 2024, the Mexican Automotive Industry Association (AMIA), which represents the country’s leading manufacturing and export sector, published a list of ten proposals to promote electromobility that summarizes the overall challenges that Mexico faces to promote industrial development in highly sophisticated sectors: “dialogue is required between the new government and industry to develop a comprehensive public policy for electromobility, as well as to work together to build minimum conditions such as sufficient, accessible and clean energy; physical and digital infrastructure in customs operations; automotive workforce with new capabilities; updated regulatory framework; and guaranteed safety conditions. This objective is to facilitate the proper operations of the automotive companies already established in the country, thereby promoting the attraction of new investments that allow their expansion.”[18]

Below, we analyze some of the main levers that can contribute to achieving this necessary transformation.

Energy and sustainability

Mexico currently has an installed capacity of 89 gigawatts, of which 32% comes from renewable sources and the rest from other technologies. The demand for the National Electric System (SEN) in 2023 was 345,439 GWh in six tariff sectors, where medium-sized companies and major industries account for 37.4% and 23.7% of SEN consumption, respectively.

Current industry growth requires adding 25 gigawatts of electricity generation capacity and an investment of nearly 40 billion dollars. Additionally, investment will be required in electricity transmission and distribution infrastructure to improve accessibility and reduce costs for end users.

Another vital energy source in Mexico is natural gas, consumption of which has grown in recent years, driven by industrial activities and electricity generation. The country recorded nearly 8.2 trillion cubic feet per day last year, with the electricity sector being the primary consumer, followed by the manufacturing and petrochemical industries. According to projections from the Cenagas National Gas Pipeline Management Center, an additional increase of 1.7 trillion cubic feet per day is expected between 2024 and 2038 due to expansion in key industries and new energy infrastructure projects.

Microprocessor manufacturing is an energy-intensive activity that begins with extracting and refining raw materials such as quartz to produce silicon. This material then undergoes purification, which requires a large amount of energy.

Once the materials are prepared, the manufacturing phase begins. This phase includes steps such as applying thin layers of materials, creating patterns for the circuits using a printing process called lithography, chemical etching, and inserting ions to adjust the properties of the material. All these phases require machinery with high electricity consumption.

The government and the private sector must work together to ensure that the required investments are realized in time to address the potential installation of new industrial parks and increases in current production.

It must also be considered that companies seeking to expand their operations in Mexico are increasingly obliged to consider not only current environmental and social impact regulations but also future changes to come in terms of products with a lower environmental impact, the transition to clean energy to reduce the carbon footprint, and responsible water management, not only in terms of consumption but also in its treatment and reuse.

Mexico, despite its natural wealth and capacity to absorb greenhouse gases (GHG), with around 70% of the world's biodiversity, ranks ninth in gross GHG emissions,[19] reflecting a higher emissions intensity than expected for an economy of its size.

Additionally, as a member of the USMCA, Mexico has multiple obligations focused on environmental protection and climate change mitigation. It has committed to complying with international agreements, such as the Paris Agreement, and implementing domestic policies to reduce GHG emissions.

Mexico has a regulatory framework seeks to protect biodiversity, conserve water resources, reduce social vulnerability, decrease greenhouse gas emissions, identify the effects of climate change, and implement adaptation actions. The principal environmental regulations to mention include the following:

- The General Law on Climate Change, which, among its many other obligations, structures, and mechanisms, establishes a responsibility to report direct and indirect emissions through the National Emissions Registry for sectors exceeding 25,000 tons of CO_2 equivalent.
- The National Water Law regulates the use, distribution, and conservation of water from 2023, with a view to comprehensive and sustainable development.
- The Sustainable Taxonomy of the Ministry of Finance and Public Credit (SHCP) guides investment towards economic activities aligned with the country's climate and sustainable development objectives.
- The Transition Strategy to Promote the Use of Cleaner Technologies and Fuels, set out by the Ministry of Energy (SENER), establishes the commitment to coordinate the energy transition in the country gradually and systematically to reach 35% of generation with Clean Energy in 2024 and a goal of 50% by 2050.[20]

In addition to federal regulations, several states have implemented sustainability laws, such as the General Law of Circular Economy in Mexico City, which promotes resource optimization, waste reduction, and reuse throughout the production chain. Similarly, the carbon taxes established in states such as Guanajuato, Querétaro, Tamaulipas, and Yucatán stand out.[21] The objectives include creating carbon markets to offset emissions and allowing these offsets to be used to pay this tax.

In parallel, organizations such as the Mexican Financial Reporting Standards Council and international certifying entities (such as ISO, Sistema B, and CEMEFI) promote sustainability transparency. For example, in 2024, the Mexican Financial Reporting Standards Council published its first Sustainability Reporting Standards (NIS),[22] Which seeks to improve the resilience of companies to sustainability challenges and facilitate strategic decision-making for sustainable growth. In addition, bodies such as Sistema B require that certified companies have net-zero emissions targets starting in 2025,[23] among other measures.

Transition to electromobility

Electric vehicles (EVs) can contain up to 3,000 microprocessors that monitor and control various processes inside the vehicle, from battery operation to onboard infotainment systems. An internal combustion vehicle has between 100 and 300 microprocessors.

The transition towards electromobility will involve an almost exponential growth in microprocessor demand. This makes it essential to create the right conditions to enable a North American microprocessor market. Secondly, it is necessary to align with the needs of and the regulations corresponding to the global goals of reducing greenhouse gases (GHG) and migrating towards a cleaner energy consumption that allows companies, governments, and individuals to reduce the consumption of energy from fossil sources such as oil and gas.

Various governments and companies committed to the objectives of the Paris Agreement have set ambitious goals for the transition to EVs as a key strategy to reduce GHG emissions. Among the commitments and policies, several car manufacturers have announced commitments to transition to exclusive EVs production in the coming years, aligning with global climate goals.

Companies like **Volvo** have set a goal of being fully electric by 2030, while **Ford** is committed to selling EVs in Europe by that year. These commitments reflect a growing trend in the automotive industry towards sustainability and decarbonization of transport.

The United States government has pledged that by 2030, half of new vehicles sold in the country will generate zero emissions, supported by a network of half a million charging stations that will facilitate the operation of electric vehicles on local and long-distance trips.

In November 2021, President Joe Biden signed the Bipartisan Infrastructure Investment and Jobs Act,[24] which made more than $7 billion in funding available for installing electric vehicle charging stations and created tax incentive programs and federal financing plans for electromobility initiatives, such as credits for acquiring vehicles and installing charging stations.

These changes are of great relevance to Mexico's strategy, given its participation in the United States-Mexico-Canada Agreement (USMCA) and its role as a key producer in the automotive industry, as companies operating in the country will have to adapt to new regulations and trends to remain competitive in a market that demands increasing standards of sustainability and energy efficiency.

Mexico has established itself as a leader in the export of electric vehicles to the United States. In the first half of 2024, Mexico exported vehicles worth more than 3 billion dollars, second only to Germany, according to United States Department of Commerce figures. This increase represented a year-on-year growth of more than 170%, placing Mexico as the second-largest exporter of electric vehicles to its neighbor, surpassing key competitors such as South Korea, Japan, and the United Kingdom.

This export boom reflects Mexico's strategic role in the global automotive industry, especially in the context of new regulations and sustainability goals reshaping the sector.

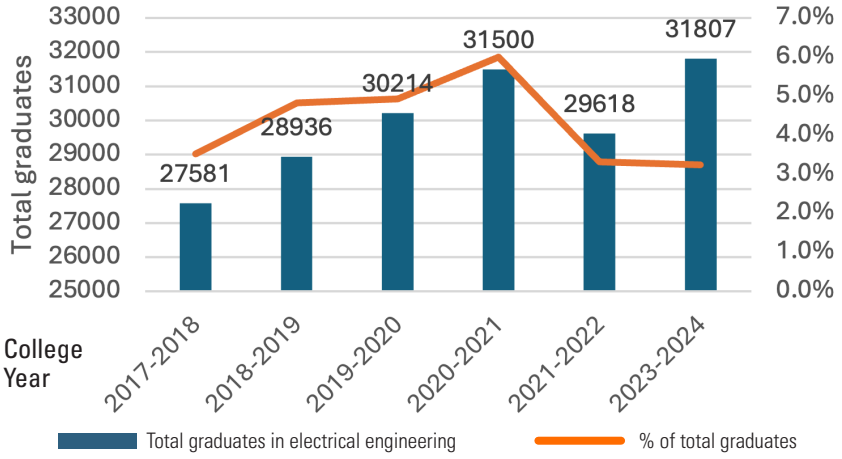
For this reason, several vehicle manufacturers (*original equipment manufacturers*, OEMs) have expanded and diversified the production of their plants in Mexico to produce electric vehicles. General Motors in Coahuila, San Luis Potosí, and Zacua in Puebla are the brands that already produce electric vehicles. German company BMW will invest 800 million euros to build a battery module production center at its San Luis Potosí plant, which is expected to begin operations in 2027.[25]

Given Mexico's growing focus on sustainability, domestic regulatory frameworks, and the demands of its trading partners, especially within the North American supply chain, it is crucial to implement rules, policies, and incentives that foster an enabling environment for developing value and supply chains. These mechanisms should support the manufacturing and automotive industries, promoting responsible practices aligned with international sustainability standards. Adopting clear and effective policies will contribute to improving Mexico's competitiveness in this sector and strengthening its strategic position within the global market.

Talent and innovation

Talent is one of the biggest challenges to positioning Mexico as a key player in integrating high-tech supply chains in North America. According to Manuel Sandoval, who leads the Industry 4.0 and artificial intelligence strategy at the Mexican Association of the Information Technology Industry (AMITI), the number of electrical engineering graduates, one of the leading careers demanded by the microprocessor sector, is not growing at the pace required to meet new job opportunities; this trend needs to be reversed to ensure that there is a workforce in place to enable the development of new industries.

Total Graduates Electronics, Automation and Applications of Mechanics-Electrics



Prepared by the authors with data from the National Association of Universities and Higher Education Institutions

Three actors—the public, educational, and private sectors—are responsible for increasing the Mexican human capital available for the microprocessor sector.

The public sector must incentivize students in fields related to semiconductor development with scholarships, grants, or support programs. At the same time, universities should update educational programs and introduce interdisciplinary programs focused on developing new skills and techniques for more complex industrial processes.

Companies should also create alliances with universities to offer mentoring programs, internships, and professional practices that provide students with early work experience.

Mechanisms and spaces must also be created so that talent can be translated through research and entrepreneurship into innovations of three types:

1. Aimed at applications that require low to moderate frequencies and power levels, used to power computers, smartphones, and various consumer devices.
2. Focused on high-frequency applications in high-speed digital circuits, microwave devices, light-emitting diodes (LEDs), and lasers.
3. This is related to microprocessors operating at higher voltages, operating temperatures, and switching frequencies than their traditional counterparts in electric vehicles, renewable energy systems, and sensors.

Mexico’s short-term opportunity lies in creating innovation clusters and companies specializing in semiconductor components in the first two categories, representing around half the semiconductor market value.

The goal is to develop the capacity to produce third-generation microprocessors gradually.

Demand by type of use (2021)

Category	Computer	Telecommunications	Vehicles	Consumer	Industrial	Government
Annual growth	23.1%	24%	37.9%	28.9%	26.6%	26.4%
Value ($B)	175	170.6	69.1	68.4	66.9	5.8
Generation	First	First	First, second, and third	First/ second	All three	All three

Source: US Mexico Foundation. *Semiconductors The Next Near-shoring Frontier.* (2024). Available at: https://usmf.squarespace.com/s/Semiconductors-101.pdf

A challenge for Mexico is to allocate resources to boost research and development work on microprocessors since Mexico's current investment is 0.5% of GDP, far from the 2.5% average established by the Organization for Economic Cooperation and Development.

Mexico can develop initiatives to encourage the development of microprocessor research and development activities in the country.

- **Tax incentives** for companies investing in and subsidies for research and development projects related to semiconductors and microprocessors.
- Construction of **infrastructure for research work**.
- Promotion of **technological ventures and spin-off companies** focused on the microprocessor industry.
- **Collaboration agreements** between companies and universities.

Infrastructure

During the first half of 2024, demand for space in Mexico's industrial manufacturing sector reached 1.2 million square meters, an increase of 39% compared to the same period in 2023. The automotive, appliance, and electronics manufacturing sectors drove this demand.

In parallel, the export of light vehicles increased by 10.7% during the first half of 2024 compared to the same period of the previous year, its highest point since 2019. According to CBRE Research, the automotive industry's demand for nearshoring increased by 37% due to interest in relocating foreign companies' operations to the country.

Jalisco has become an epicenter of the national semiconductor industry, hosting approximately 70% of the companies in the sector. Such growth has been driven by national and foreign investments, especially in states in the Bajío and northern part of the country. Companies such as QSM Semiconductors, Micron, and Foxconn have installed plants and engineering centers in Querétaro and Jalisco, seeking to strengthen the production and design of chips in Mexico for automotive and consumer applications.

In addition to industrial space, it is also necessary to strengthen the country's transport infrastructure, which includes roads, railways, ports, and airports, essential for domestic and international trade:

1. **Highway network**: Mexico has approximately 400,000 kilometers of roads, including 50,000 kilometers of federal highways and highways vital for the distribution of goods. This infrastructure faces congestion and maintenance problems, especially in industrial corridors in Bajío and the country's north.
2. **Railroad Infrastructure**: With a length of 26,000 kilometers, the railroad network connects industrial areas and ports, facilitating the transport of heavy goods. Its expansion through projects such as the Tehuantepec Isthmus Interoceanic Corridor seeks to improve connectivity between the Gulf of Mexico and the Pacific, offering transportation alternatives to the Panama Canal.
3. **Seaports**: The Mexican ports of Manzanillo, Lázaro Cárdenas, Altamira, and Veracruz are crucial for importing and exporting goods. Manzanillo handles more than 40% of the containerized cargo that moves through the country. Port modernization projects have increased capacity in response to demand arising from company relocations. However, the challenge of managing potential saturation situations in the capacity to handle container traffic remains.
4. **Airports and air cargo**: Mexico City International Airport (AICM) and Felipe Ángeles International Airport (AIFA) handle most of the country's air cargo. In 2023, AICM reported more than 570,000 tons of cargo, while AIFA is taking on part of this flow to improve distribution.

Among the main areas of opportunity to strengthen transport and logistics infrastructure are:

- Improve the **maintenance and capacity** of the national road network.
- **Expand and diversify the railroad network** to better connect industrial regions.
- **Investing in port technology and capacity** to improve efficiency and load management.
- **Increase renewable energy generation** to attract companies that prioritize sustainability.
- **Digitize logistics processes** to optimize the supply chain and improve traceability.
- **Optimize computer systems** at customs agencies to streamline communication and accelerate inspection operations at border crossings.

Public policy and tax incentives

The Mexican federal government has established policies and initiatives to improve the microprocessor industry environment through tax incentives and international alliances.

A presidential decree was published in the Federation's Official Gazette to attract key industries, such as semiconductors and electric vehicles.[26] This year, Mexico and the United States formed an alliance under the International Technology Innovation and Security Fund (ITSI) created by the CHIPS Act of 2022 to strengthen the global semiconductor supply chain and develop talent in collaboration with Arizona State University.[27]

In turn, the Ministry of Economy signed an agreement with Intel in 2022 to promote the transfer of technological innovation resources and train specialized microprocessor talent in the country.[28] Finally, this year, the Mexican federal government published a decree launching a collaboration agreement to promote the development of the semiconductor industry in Mexico.[29]

However, there are areas for possible improvement. Mexico needs to collaborate with its trading partners to improve the services provided by immigration authorities, with an emphasis on the provision of consular services, access to work visas for all, but especially for Taiwanese nationals, and the availability of one-stop shops for investor assistance segmented by industry through the Ministry of Economy. This expedites dialogue and provides prompt attention to foreigners and expatriates seeking to relocate to Mexico for work or investment reasons.

The federal government has already promoted local public policies accompanied by fiscal measures and incentives; however, additional guidelines and regulations are required that should start at a national level (probably through a national plan) and then be implemented locally at the state level.

A harmonized regulatory reform starting with the states, including policies, guarantees, and incentives that provide certainty and legal validity to international companies that see Mexico as a strategic investment opportunity for nearshoring, is the path for the country to become a leading player in the microprocessor industry.

05 | Final Recommendations and Advice

Having traveled the path from the opportunity represented by current geopolitical movements to integrate a high-tech North American regional supply chain to the specific role that Mexico plays in this vision of "*Designed in North America*" and the challenges that it faces in carrying it out, the main pillars of specific action for government, companies, and academia are summarized below, a "to-do list" that, with humility, we offer as a team to the different agents because without joint and concerted actions this will not fly.

We hope that you, the readers, feel free to use and share these recommendations because our team's vision has always been one of research for action.

We also offer a few final paragraphs of intergenerational reflection around the goal that we believe is offered by this juncture where only the "antifragile," those who, according to the author Nassim Taleb, grow in the face of chaos and uncertainty and will prosper in the face of the stressors that the future holds for us.

Lines of action for decision-makers in the public sector

- **Establish dialogues between the business, academic, and government sectors (Federal and State)** to develop policies, mechanisms, and programs that encourage investment by companies already established in the country and attract new international investments.
- **Promote scholarships, grants, and support programs** for students pursuing careers related to technological development in STEM (scientific, technological, engineering, and mathematical) skills.
- **Establish funding programs** that promote research and development initiatives in microprocessor technology and its applications.

Lines of action for private sector leaders

- **Seek alliances with universities** to offer mentoring, internship, and practicum programs that provide students with early work experience in microprocessor development areas.
- **Promote consortia with regulatory entities** to help establish technical norms and standards, promote innovation and learning, and foster participation in national and international forums.
- **Promote the development of industrial clusters** to build a business ecosystem that shares markets, technologies, inputs, and labor, driving an integrated value chain.

Lines of action for university leaders

- **Update training programs and introduce interdisciplinary programs** focused on developing new skills and techniques for more complex industrial processes.
- **Create university research centers** dedicated to advanced research, collaborate with leading industry partners, and offer specialized educational programs.
- **Foster collaborative dialogue between academia and government** focused on high school students around the new technical capabilities and skills required within professional careers to be able to face the challenges and labor demands of the future.

Dreaming big is not the monopoly of one faction or one party. We are the hemisphere that bears the name of the person who drew it on the world map: Amerigo Vespucci. As a region, North America has strengths superior to those of other parts of the globe.

Our provocation with this essay is to show the concept of ***Made in North America*** at the center of the discussion for the remainder of the 21st century. This concept emerges from a deep belief in the complementarity between Canada, Mexico, and the United States. No one can be great in isolation.

Each nation must be concerned about its domestic environment but in the grand scheme of things, harmonious interaction among the three nations will create a winning region of shared prosperity. We are countries that complement each other economically and, above all, demographically.

When historians look back at our time, the first quarter of the 21st century, they will not see politician A or policy B, party X or Y; they will see the opportunities that lie ahead, massive opportunities to grow computing power in an era of Artificial Intelligence that is just beginning and that merits a study of its impact in the region.

It is self-evident that Mexico, the United States, and Canada want to—and should—take advantage of the opportunities that exceed the risks. This moment is North America's, a clear and straightforward moment to harness our joint power and say at the top of our lungs:

CARPE DIEM!

Addendum

We present this study aware that President Donald Trump's first administration, between 2017 and 2018, used extensive rhetoric about the possibility of imposing tariffs on all productive sectors.

At that time, the willingness of the three trading partners to negotiate prevailed. They collaborated in the comprehensive review of the free trade agreement, then known as NAFTA, which later became the United States-Mexico-Canada Agreement (USMCA), the current framework of our trade relationship. We believe that in the months and years ahead, we will face a similar period of intense exchanges of statements, some vitriolic, followed by negotiations at all levels.

The first weekend of February 2025 was a case in point. It was not for nothing that *The Economist* indicated last autumn that Mexico is the nation most exposed to the ups and downs of the current US administration, according to its Trump Risk Index. The opportunities are real, as seen in these pages, but so are the risks.

President Claudia Sheinbaum's government has established a Plan Mexico strategy to extend tax benefits to those who invest and create jobs in Mexico; it is worth reviewing thoroughly. However, a trade war could break out between the USMCA partners by action or omission, the outcome of which would be unfathomable.

We are convinced that if the actors invoked in this study consistently and coordinately display their willingness, the interest of the members of this region called North America in building a tri-national community, specifically around the topic of this research: microprocessors, will prevail. As we have documented, it is in everyone's interest that this happens.

We hope that no one will shoot themselves in the foot along the way and that you, readers interested in shared prosperity, will act as allies in a project that can, through actions designed to do so, benefit the more than 500 million inhabitants at the regional level and specifically those in your respective countries. The region is not in conflict with the locals.

In this age where chips are the new indispensable linkage for our technological society and increasingly for emerging generative artificial intelligence services, being part of a value chain with the proud name "Designed in North America" will make all the difference in the tenacious economic competition of the 21st century and will distinguish between winners and losers in the ongoing contest. The lines of action we have described represent our intergenerational contribution so that decision-makers in Mexico and the other countries that belong to this region can discuss the tools utilizing which the public, private, and academic sectors can act as efficient bridges of dialogue.

This dialogue is indispensable to growing the real concept of North America, something more than just a geographical region where Canada, the United States, and Mexico meet. It is a meeting point for talents, people, and innovations.

Rossana Fuentes Berain | Mexico City, February 2025

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