MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

BRAZILIAN GOVERNMENT BRASIL UNITING AND REBUILDING

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# Strengthening EU-Brazil bilateral know-how of semiconductor sector technology and possibilities for cooperation on trade and R&D

July 2023

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# EXECUTIVE SUMMARY

*"The challenge we all face is the same, both in Brazil and in Europe. At times of increasing global risks – due to war but also to climate change and to great power competition – we all have to de-risk our supply chains. And for this, we need reliable partners. Friends who share our values, and whom we can truly trust".*

President of the European Commission, President von der Leyen, addressing the Brazilian National Industry Confederation in Brasilia, on the 12 June 2023

The European Union (EU) focus on the need to de-risk supply chains reflects the fact that supply chains are the nervous system of the European economy. Up to 30% of total EU value added relies on functioning cross border supply chains, either as a source of input or as a destination for production.[1]

This EU message on supply chain resilience was further elaborated in the Joint Communication to the European Parliament, the European Council and the Council on "European Economic Security Strategy[2]": *"The EU cannot achieve economic security on its own…The global economy will remain integrated and interconnected, and effective EU action depends on cooperation and coordination with others. De-risking supply chains and mitigating disturbances involves diversification of supply and access to a diverse set of import and export markets".*

One of the three key priorities of this European Economic Security Strategy is Partnering with countries who share our concerns on economic security as well as those who have common interests and are willing to cooperate with us to achieve the transition to a more resilient and secure economy. In practice this means working together with the broadest possible range of partners to reinforce economic security, foster resilient and sustainable value chains, and strengthen the international rules-based economic order and multilateral institutions.

The President of Brazil, President Lula, also addressed this need for partnerships during the recent visit of President Von der Leyen to Brazil, stating *"We want to establish an effective Digital Partnership with the European Union, in the areas of information technologies, regulation of the digital space, 5G and semiconductors."*

1 Accenture Research analysis of OECD TiVA and Oxford Economics Industry Databank

2 20.6.2023 JOIN(2023) 20

This report "**Strengthening EU-Brazil bilateral know-how of semiconductor sector technology and possibilities for cooperation on trade and R&D**" lays the groundwork for exploring such an EU-Brazil partnership in the semiconductor sector. The report, produced during the first half of 2023, was commissioned by the European Union – Brazil Dialogues Support Facility on behalf of the EU and the Brazilian Ministry of Science, Technology and Innovation. The action is intended to promote mutual understanding of respective semiconductor supply chains and policies, to facilitate future actions to strengthen a bilateral strategic partnership in the semiconductor sector.

In this report, Chapter 2 provides an overview of the global semiconductor industry manufacturing landscape and in particular, the Brazilian and EU positioning in key segments of the semiconductor supply chain. A key take-away is that production of chips takes place in a semiconductor supply chain that is global, complex and, in some important segments, such as manufacturing or packaging, very concentrated. At the front-end of the supply chain, only two companies in the world, located in Taiwan and South Korea, are capable of manufacturing the most advanced logic chips at the most advanced 3nm chip nodes. At the back-end, the global assembly, test and packaging (ATP) industry is heavily concentrated in Asia, with the EU holding less than 5% of this segment. Outside of Asia, Brazil is the 2$^{nd}$ largest Outsourced Semiconductor Assembly and Test (OSAT) hub providing third-party IC-packaging and test services. However, it is acknowledged that this landscape is now changing significantly under the impetus of the US and EU Chips Acts.

From a semiconductor market perspective, it is also shown in Chapter 2 that over 70% of the expected growth in the global semiconductor market value will come from only three sectors: Automotive, Communications, and Computing & Data storage. The strong global dominant positioning of EU companies all along the Automotive semiconductor supply chain from semiconductor components through Tier 1 suppliers to Vehicle OEMs is detailed.

Chapter 3 describes the segmentation of the semiconductor value chain and provides a detailed mapping of key Brazilian and EU industry active within the different segments of their semiconductor supply chain, starting from design through materials and equipment to manufacturing and advanced packaging. Cognisant of key semiconductor markets, the report also details Brazilian and EU industry in two of the identified strategic industry sectors, namely, automotive and communications.

The EU analysis also classifies industry by Member State headquarters, by typology of company involved, Large Enterprise (LE) or Small and Medium Enterprise (SME), and by company, if Automotive or Communications, as discussed above.

From the EU perspective, the aim was not to provide an exhaustive list of EU companies along the supply chain which runs into the hundreds of LE's and thousands of SME's. but rather a more strategic and granular analysis of EU semiconductor companies active in the EU flagship semiconductor research and development programmes such as the Key Digital technologies Joint Undertaking. The intend being to compile a list of companies with a strong DNA of collaborating on semiconductor technology and supply chain challenges.

The specific EU mapping and analysis confirms the global semiconductor landscape of Chapter 2. The EU strengths and collaboration in the semiconductor materials and equipment segments is clearly visible, as is the EU manufacturing capacity and capability for the automotive, and communications.

However, a key observation is that this current EU semiconductor manufacturing landscape will be dramatically changed over the coming three years, triggered by the EU Chips Act and related instruments. Several examples of planned investments are described including; the future Intel semiconductor fabs in Magdeburg, Germany, the future Wolfspeed 200mm silicon carbide device manufacturing plant in Saarland, Germany, the future Infineon - Smart Power Fab - semiconductor plant in Dresden for analog/mixed-signal technologies and power semiconductors and most recently, on the 5th of June 2023, the announcement by GlobalFoundries Inc. and STMicroelectronics to build a new, jointly-operated, 300 mm high-volume semiconductor manufacturing facility in Crolles, France.

The strong Brazilian semiconductor packaging industry is confirmed along with the relatively weak EU position in this segment. However, once again it is noted that the EU positioning in the critical advanced packaging segment of the semiconductor value chain is now changing significantly under the impetus of the EU Chips Act. A number of examples are given including: the expansion of the only high-volume, advanced packaging, Tier 1 OSAT in Europe (Amkor, Porto, Portugal), the creation of the first at-scale Services OSAT in Europe through a strategic partnership between Amkor Technology, Inc and GlobalFoundries., and most recently, on the 16th of June, the Intel announcement of the establishment of a cutting-edge semiconductor assembly and test facility in Wroclaw, Poland.

Chapter 3 also provides a mapping of key Brazilian and EU research players in their respective semiconductor ecosystems. Both countries have a strong semiconductor research and education capacity and capability, providing many future opportunities to address one of the key semiconductor industry challenges today and into the next decade, the rapidly emerging semiconductor staff shortage at all levels and in all segments of the semiconductor supply chain.

A future Brazilian-EU semiconductor sector collaboration will require a joined-up thinking across both their internal and external support policies. Chapter 4 presents a review of current Brazilian and EU public policies, instruments and incentives to support their respective semiconductor industry, their semiconductor supply chains, and downstream sectors.

The key Brazilian Policy Instruments in the Semiconductor Sector, along with those for the Automotive and Communications sectors are; PADIS (Support Program for the Technological Development of the Semiconductor Industry), the ICT Law (Informatics and Communication Law) for companies in the information and communication technologies (ICT) sector, the Rota 2030 (Route 2030) Law 13.755/18 for support of companies in the automotive sector and the Lei do Bem (Good Will) - Law 11.196/05 which supports all companies across all sectors performing technological innovation.

The EU policy and support initiatives in the field of semiconductors that are described include; the European Chips Act, the Important Project of Common European Interest (IPCEI) on microelectronics, the Recovery and Resilience Fund, RDI programmes such as the Joint Undertakings and relevant parts of Horizon Europe, the European Innovation Council and the Digital Europe Programme. The recent IPCEI on Microelectronics

and Communication Technologies[3], approved by the European Commission on June 8, 2023, with €8.1 billion of state aid, and triggering €13.7 billion of additional private investment and therefore a total investment of around €22 billion in the European semiconductor supply chain, reflects this new momentum and determined use of available instruments.

Finally, Chapter 5 presents both the overall conclusions of the semiconductor mapping exercise and policies review, along with several recommendations for supporting and strengthening the respective ecosystems and supply chains.

The several policy recommendations in Chapter 5, are grouped in three thrust areas; increasing industry collaboration (Recommendations 1-3), enhancing inter-regional semiconductor ecosystems across all areas including education, training and best-practices (Recommendations 4-6), and finally, a cross-cutting initiative to coordinate actions and share intelligence to improve the resilience of future Brazilian and EU semiconductor supply chains (Recommendation 7).

In short, these are:

- **RECOMMENDATION 1: Increase Brazilian and EU industry collaboration in strategic semiconductor research and development programmes**, including, where possible, through making full use of future semiconductor R&D opportunities under the Chips Joint Undertaking and any other appropriate industry focused RDI partnerships
- **RECOMMENDATION 2: Strengthen the industrial partnerships and value chain linkages between Brazil and the EU in the semiconductor supply chain for automotive and communications**, to improve the resilience of global value chains and boost the competitiveness of EU and Brazilian industries globally. Leverage, where possible, the existing EU corporate linkages in Brazil (including EU subsidiary's corporate research centres in Brazil). Facilitate participation of EU corporate research centres in Brazil in European innovation programmes.
- **RECOMMENDATION 3: Promote an EU - Brazil SME platform and actions to accelerate the growth of high-tech SMEs and start-ups**, through linkages and cooperation between identified SME players in the semiconductor supply chain. This action could leverage existing EU platforms such as the European Enterprise Network (with dedicated sustainability advisors), the European Digital Innovation Hubs in the semiconductor or automotive and communications sectors, and the EU Start-up Nations initiative.
- **RECOMMENDATION 4: Create interregional Brazilian – EU semiconductor partnerships to boost trade, supply chain competitiveness and innovation.** Brazilian and EU regions with their clusters and industrial partners would be encouraged to take part in this initiative and to develop a pipeline of semiconductor investment projects. This action could leverage the EU Smart Specialisation Platform and expertise.
- **RECOMMENDATION 5: Enhance semiconductor ecosystem cooperation and communication through a joint EU-Brazil Semiconductor Competence Centre.** This joint competence centre would connect

3 Commission approves up to €8.1 billion of public support by fourteen Member States for an Important Project of Common European Interest in microelectronics and communication technologies; https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3087

Brazilian actors to the emerging network of EU Member State semiconductor competence centres and likewise, connect EU actors to the rich network of Brazilian state centres and APCI program centres.

- **RECOMMENDATION 6: Promotion bilateral initiatives on postgraduate education and training of semiconductor engineers, technologists, scientists and entrepreneurs**. For example, an opportunity might be the participation of Brazil in an EU Erasmus Mundus Joint Masters study programme on semiconductors. From a Brazilian perspective, to consider an adaptation of the former Brazilian "Science w.o. borders" program repurposed to an EU-Brazil Semiconductors w.o. borders program).
- **RECOMMENDATION 7: Coordinate actions and share intelligence to improve the resilience of Brazilian and EU semiconductor supply chains,** including monitoring the functioning of the Brazilian and EU semiconductor supply chains, as well as detection and response to crises through coordinated correcting measures. This action could leverage and reinforce the EU Semiconductor Alert System[4] now in place since May 2023 to monitor the EU semiconductor supply chain.

It is the hope of the authors that this report and the above seven recommendations lay the foundation for exploring a partnership in the semiconductor sector between Brazil and the European Union.

4 https://ec.europa.eu/eusurvey/runner/Semiconductor_Alert_System

# 1 INTRODUCTION

Semiconductor chips are the essential building blocks of digital and digitised products. From smartphones, through critical infrastructures for energy, mobility and industrial automation, chips are central to today's digital economy.

Chips are strategic assets for today's industrial value chains. With the digital transformation, new markets for the chip industry are emerging such as highly automated cars, cloud, Internet of Things, connectivity, space and supercomputers.

Semiconductor chips are also crucial to key digital technologies of the future, including artificial intelligence (AI) and 6G. Put simply, there is no "digital" without chips[5].

Recent global semiconductor shortages forced factory closures in a range of sectors, from cars to healthcare devices. This made more evident the extreme global dependency of the semiconductor value chain on a very limited number of actors in a complex geopolitical context.

The President of the European Commission, President von der Leyen, addressing the Brazilian National Industry Confederation in Brasilia (CNI), on the 12 June 2023, stated "the challenge we all face is the same, both in Brazil and in Europe. At times of increasing global risks – due to war but also to climate change and to great power competition – we all have to de-risk our supply chains. And for this, we need reliable partners. Friends who share our values, and whom we can truly trust".

Both Brazil and the EU have engaged in fruitful dialogue on Information and Communication Technologies (ICT) for more than 13 years and deepened bilateral cooperation in the field of smart cities, Internet of things and 5G. Both have also recently emphasised the importance of their semiconductor supply chains for future economic competitiveness and strategic autonomy.

This study provides a timely overview of the semiconductor supply chain in each country. It provides a snapshot in time of the key Brazilian and EU industry active along different segments of the supply chain. The study also maps key players in two identified strategic industry sectors, automotive and communications. The study also analyses current public policies, instruments and incentives to support the semiconductor industry, the semiconductor supply chain and specific measures for the automotive and communications industries.

5 A Chips Act for Europe, Brussels, 8.2.2022 COM(2022) 45 final

This study (carried out primarily in Q1-Q2 of 2023) was commissioned by the European Union – Brazil Dialogues Support Facility on behalf of the European Union and the Brazilian Ministry of Science, Technology, and Innovations. The action is designed to promote mutual understanding of respective semiconductor supply chains and facilitate future actions to strengthen a bilateral strategic partnership in the semiconductor sector.

The core of this study is structured into the following four chapters:

- Chapter 2: The global semiconductor manufacturing landscape
- Chapter 3: Mapping of the Brazilian and EU semiconductor industry and research actors along the semiconductor supply chain
- Chapter 4: A review of Semiconductor Sector Policy Instruments at Brazilian and European Union level
- Chapter 5: Conclusions and recommended policy actions

# 2 THE GLOBAL SEMICONDUCTOR INDUSTRY MANUFACTURING LANDSCAPE

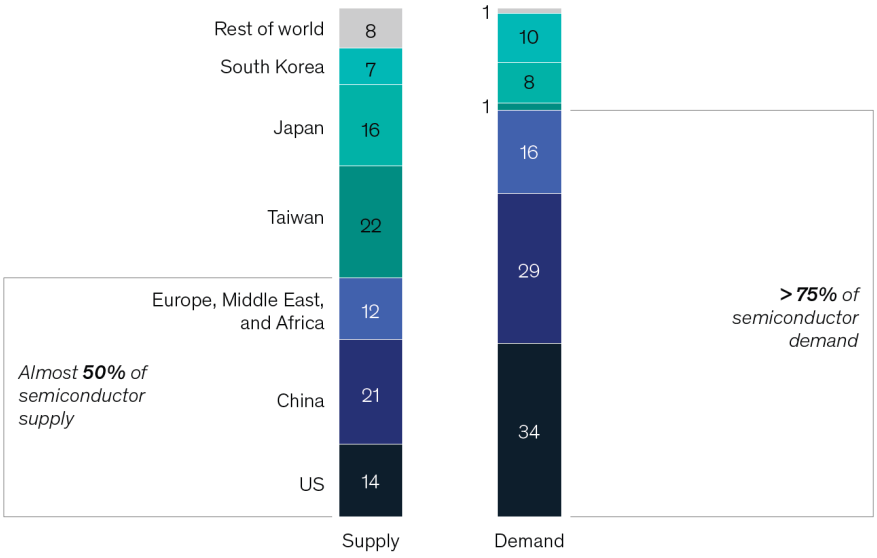
The key observations are the following:

- Semiconductor Supply and Demand is Not Regionally Balanced
- Key global semiconductor companies located in only a small number of countries
- Regional Semiconductor Chip Production Varies by Node Size
- Overall Growth in the Semiconductor Market is Driven by the Automotive, Comms (Wireless) and, Computing & Data storage
- EU Has Strong Position in Automotive Semiconductor Supply Chain
- Growing Automotive Opportunity for EU Semiconductor Supply Chain

## SEMICONDUCTOR SUPPLY AND DEMAND IS NOT REGIONALLY BALANCED

It is noted in Schematic 1 below that Asia dominates the supply of semiconductors.

**Semiconductor supply and demand, by region in 2021,**[1] % share

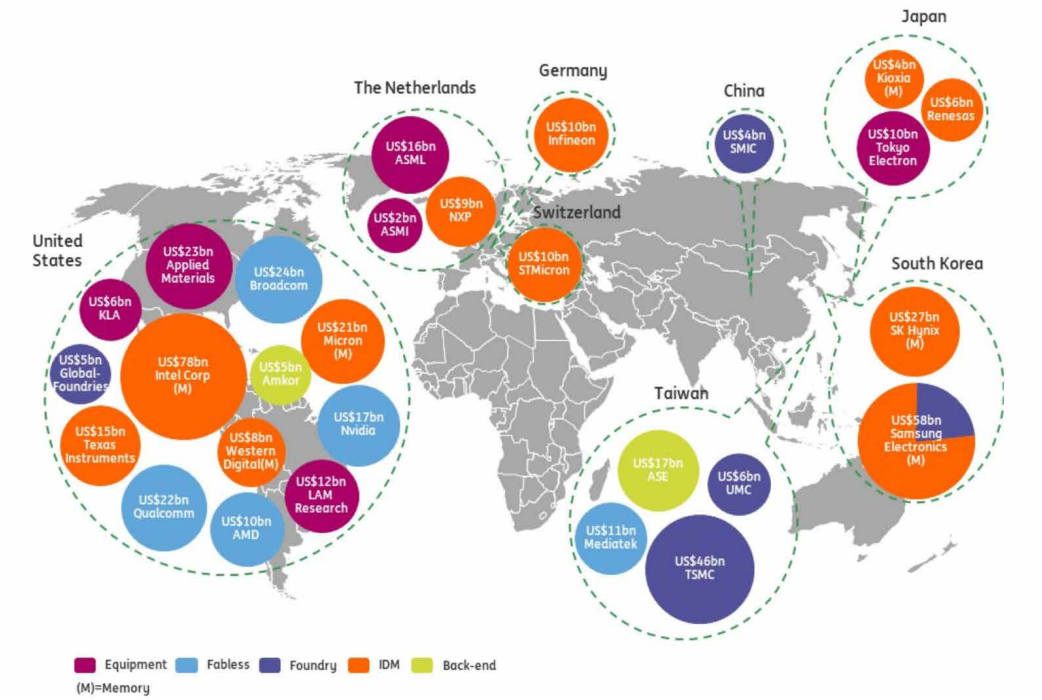



[1]Based on 300 mm equivalent, million wafers per year in 2021. Figures do not sum to 100%, because of rounding.
Source: IC Insights; IHS Markit; SEMI World Fab Forecast database

*Schematic 1: Semiconductor Supply and Demand, by region, in 2021*

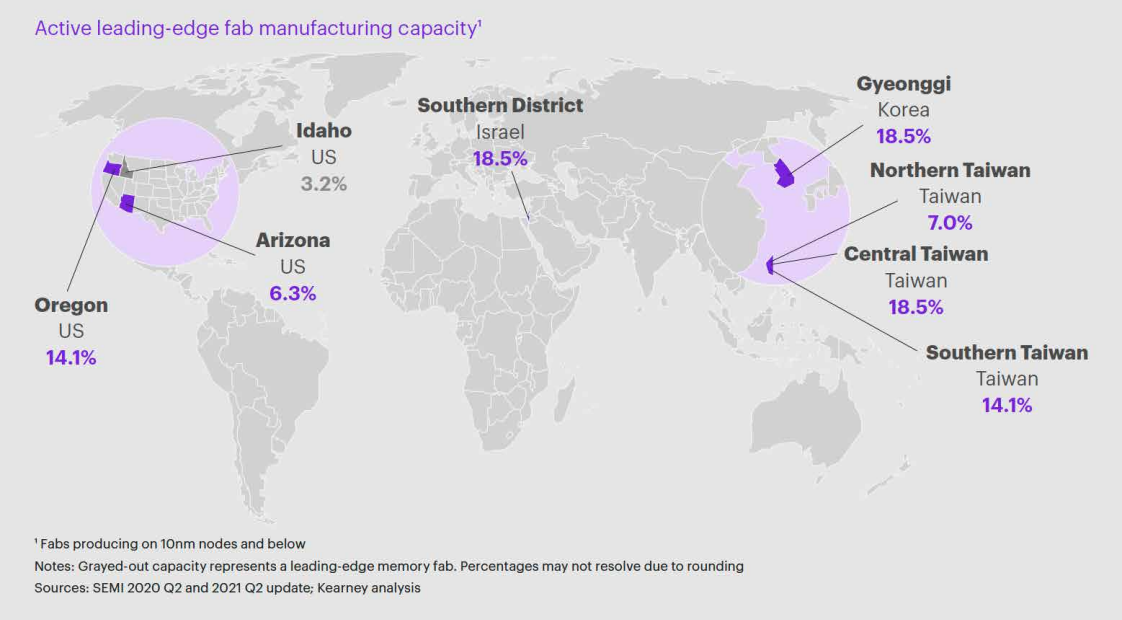
# KEY GLOBAL SEMICONDUCTOR COMPANIES LOCATED IN ONLY A SMALL NUMBER OF COUNTRIES

Reflecting the fact that Semiconductor Supply and Demand is not regionally balanced and the ongoing consolidation of the semiconductor industry, key global semiconductor companies are located in only a small number of countries as shown below (Schematic 2).




*Schematic 2: Global semiconductor companies are located in only a small number of countries*

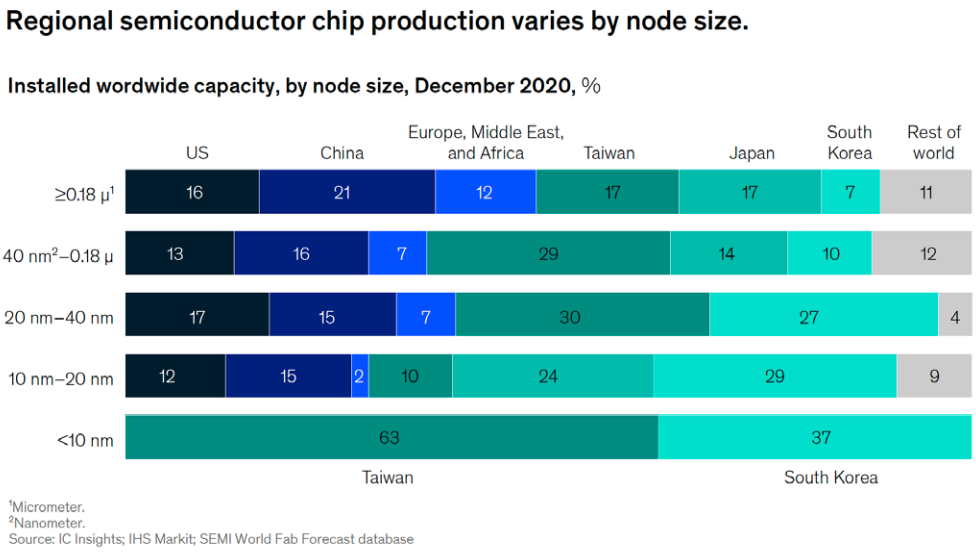
In particular, global semiconductor manufacturing capability below 10nm in restricted to only a very few countries (Schematic 3 below).




*Schematic 3: Semiconductor Fabs producing on 10nm nodes*

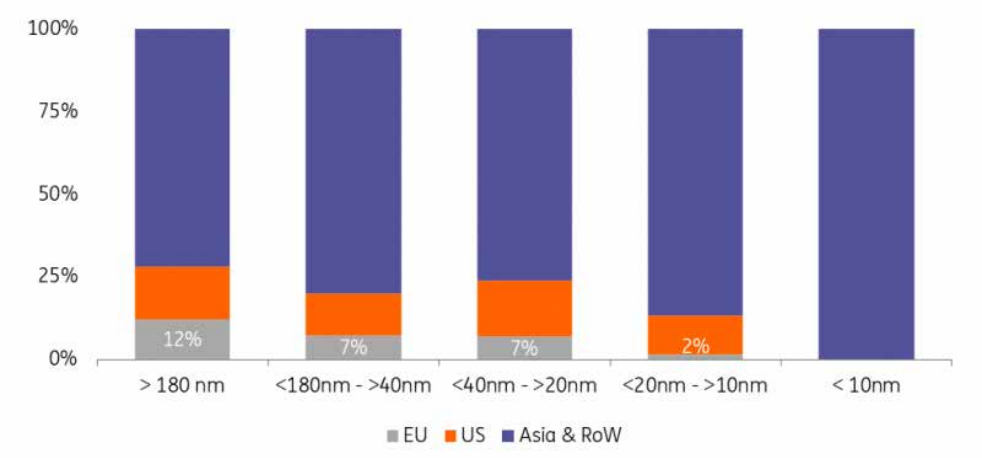
# REGIONAL SEMICONDUCTOR CHIP PRODUCTION VARIES BY NODE SIZE

Production of chips takes place in a semiconductor supply chain that is global, complex and, in some important segments, such as manufacturing, overly concentrated. For example, today only two companies in the world, located in Taiwan and South Korea, are capable of manufacturing the most advanced chips at the most advanced chip nodes, as shown below in schematic 4.




*Schematic 4: Installed worldwide capacity, by node size and Region (December 2020)*

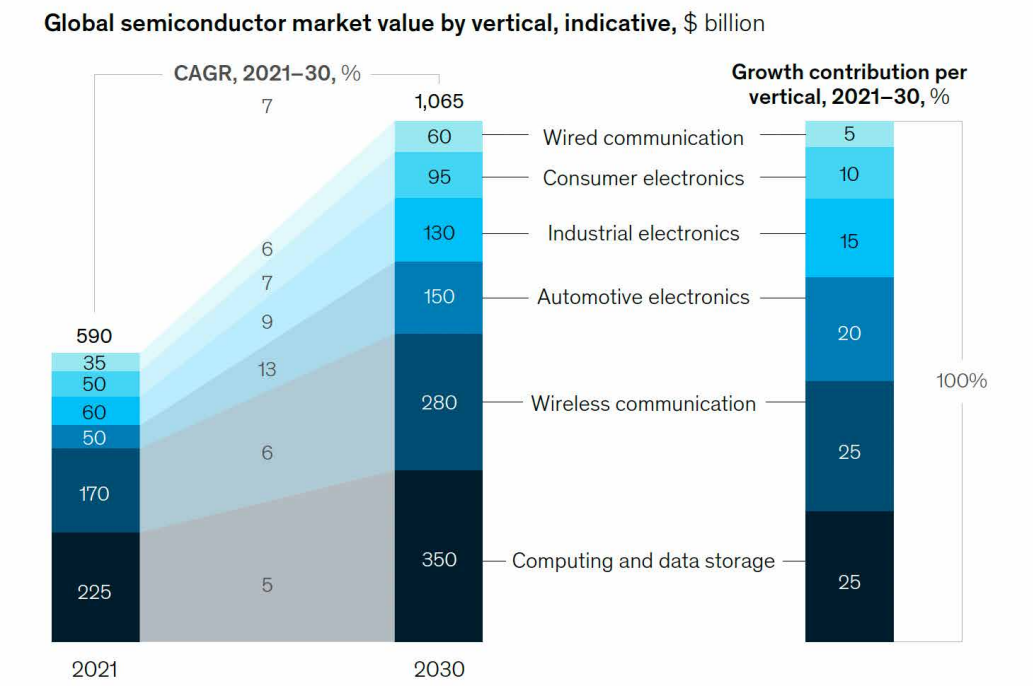
This dominance of Asia in the Global market share of wafer capacity for various node sizes is well illustrated below in schematic 5:




*Schematic 5: Global market share of wafer capacity for various node sizes (Source IC Insights December 2020)*

## OVERALL GROWTH IN THE SEMICONDUCTOR MARKET IS DRIVEN BY THE AUTOMOTIVE, COMMUNICATIONS AND COMPUTING & DATA STORAGE INDUSTRY SECTORS.

Over 70% of the expected growth in the global semiconductor market value will come from three sectors, Automotive, Communications and Computing & Data storage as shown below in Schematic 6.




*Schematic 6: Global semiconductor market growth per vertical*

# EU HAS A STRONG POSITION IN THE AUTOMOTIVE SEMICONDUCTOR SUPPLY CHAIN

The EU Has a strong position all along the Automotive Semiconductor Supply Chain up to Vehicle OEMs, as demonstrated by the EU players (in blue dotted boxes) in the supply chain schematic 6 below.


*Schematic 7: EU position along the Automotive Semiconductor Supply Chain up to Vehicle OEMs (EU players in blue dotted boxes)*

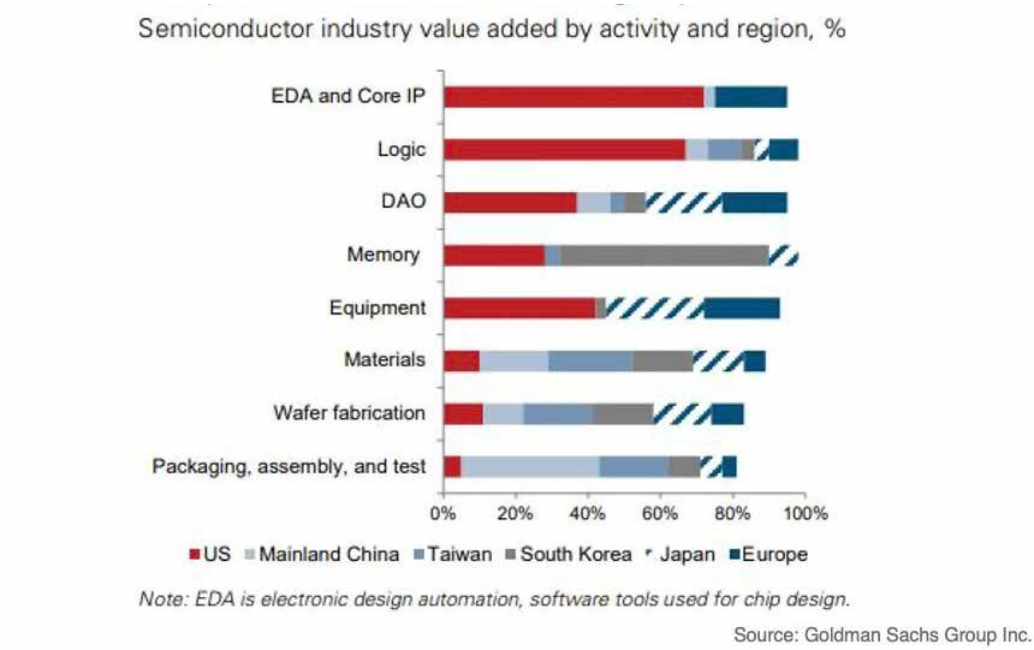
# GROWING AUTOMOTIVE OPPORTUNITY FOR BRAZILIAN AND EU SEMICONDUCTOR SUPPLY CHAINS

The value share of electronics in a car is increasing rapidly. This is driven by three factors: autonomous driving, comprehensive connectivity and the electric drive train. The financial outlay for electronic modules in a premium vehicle will more than double by 2025 for a semi-autonomous, electrified car as compared to a classic combustion engine is currently around €3,000. This will create enormous opportunities for a broadened semiconductor supply chain as shown for the EU example in schematic 8.


*Schematic 8: Broadened semiconductor supply chain for EV*

# GLOBAL ADVANCED PACKAGING LANDSCAPE

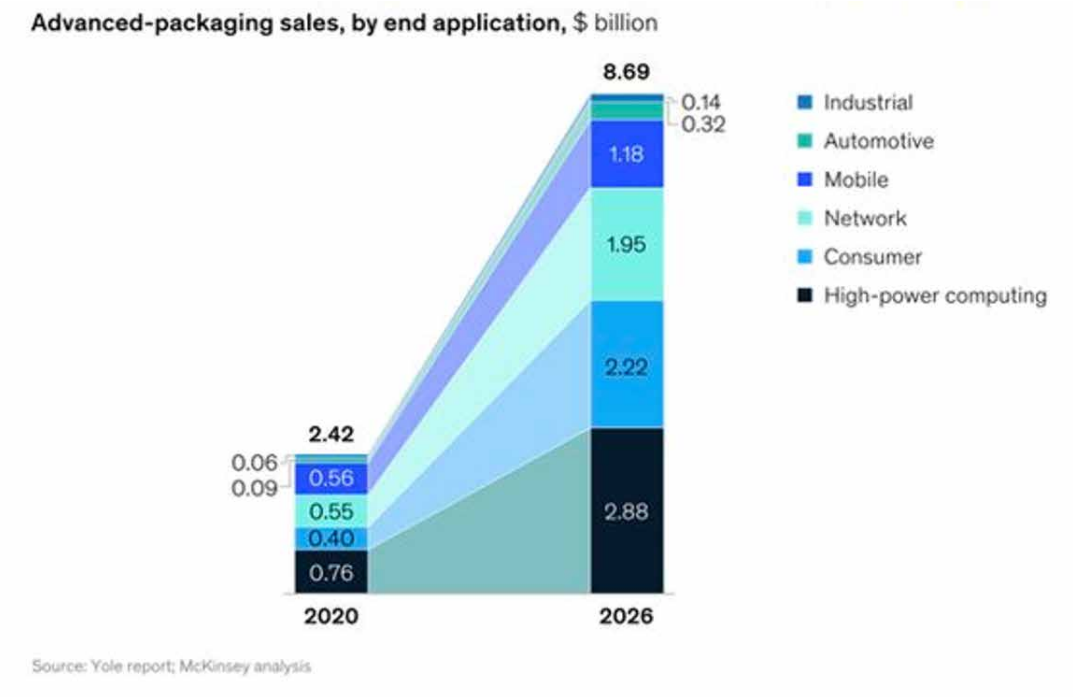
The global assembly, test and packaging (ATP) industry is heavily concentrated in Asia as shown in schematic 9 below.




*Schematic 9: EU share of Packaging, assembly and test semiconductor supply chain segment*

Outside of Asia, Brazil is stated to be the 2nd largest Outsourced Semiconductor Assembly and Test (OSAT) hub providing third-party IC-packaging and test services. The EU has currently less than 5% of the global market share in this segment, with Amkor (Porto, Portugal) the only high-volume, advanced packaging, Tier 1 OSAT in Europe.

Of particular interest in the future semiconductor supply chain is the advanced packaging market. This market is driven by applications as shown in schematic 10 below:




*Schematic 10: Advanced packaging sales, by end-application, 2020-2026*

Geopolitical tensions are making advanced packaging even more crucial. Supply chain diversification and constraints are shaping a market expected to reach 78b$ by 2028 with 10.6% range over 2022-2028.

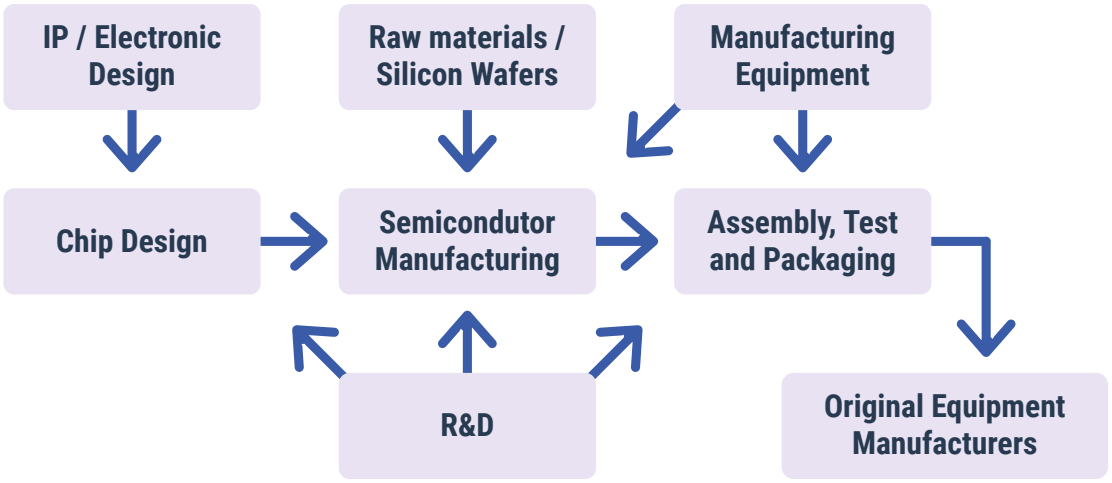
The Advanced Packaging industry attained a market value of $44.3 billion in the year 2022. This market is expected to surpass $78 billion by 2028, showcasing a CAGR of 10% during the period from 2022 to 2028.

The largest market in 2022 was the 'Mobile & Consumer' sector, which accounted for more than 70% of the total revenue. However, it is expected that this share will decrease to 61% by 2028 as the 'Automotive' and 'Telecom & Infrastructure' sectors gain larger market shares. These two sectors are projected to be the fastest-growing markets by 2028, with respective CAGRs of 17% and 10%.

A capacity and capability in advanced packaging is therefore crucial to securing Brazilian and EU ambitions in the Automotive and Communications sectors. This is further addressed in the mapping of the Brazilian and EU semiconductor ecosystems in the next Section of the report.

# 3 MAPPING OF THE BRAZILIAN AND EU SEMICONDUCTOR INDUSTRY AND RESEARCH ACTORS ALONG THE SEMICONDUCTOR SUPPLY CHAIN

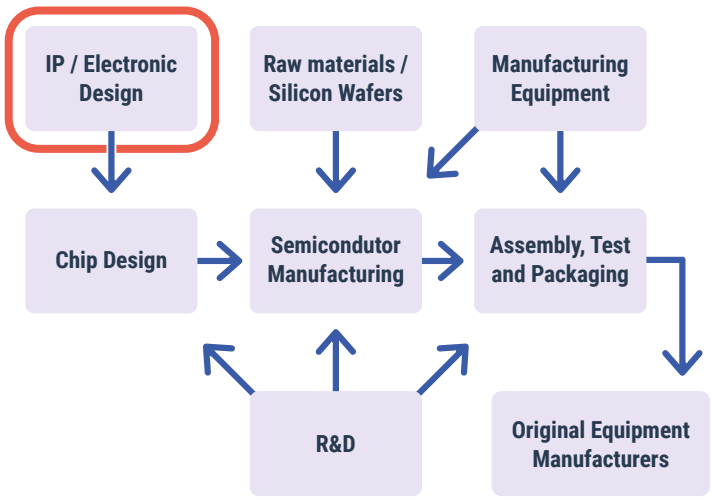
The semiconductor supply chain mapping is mapped within the generic segments shown below.




The mapping includes all actors on the Brazilian side and those actors that are research active within key European Commission research programmes on the European Union side.

# SEMICONDUCTOR SUPPLY CHAIN: IP / ELECTRONIC DESIGN

The semiconductor manufacturing process and supply chain begins in design. Semiconductors are highly complex products to design and manufacture, especially as the number of transistors on a single chip grows to tens if not hundreds of billions.




Highly specialized software known as electronic design automation (EDA) has become necessary to manage the resulting set of complex interactions and layers.

Equally, certain portions of a chip's design can be built using reusable pieces of intellectual property (IP), called core IP, that firms license to lessen the burden of the complex design process.

This segment therefore includes both design automation software companies known as electronic design automation (EDA) companies, core IP companies and services companies.

The EU companies involved in the Semiconductor supply chain – IP and electronic design segment, classified by company type, Large Enterprise (LE) or Small and Medium Enterprise (SME), and if in a sector of interest, Automotive or Communications, are detailed below:

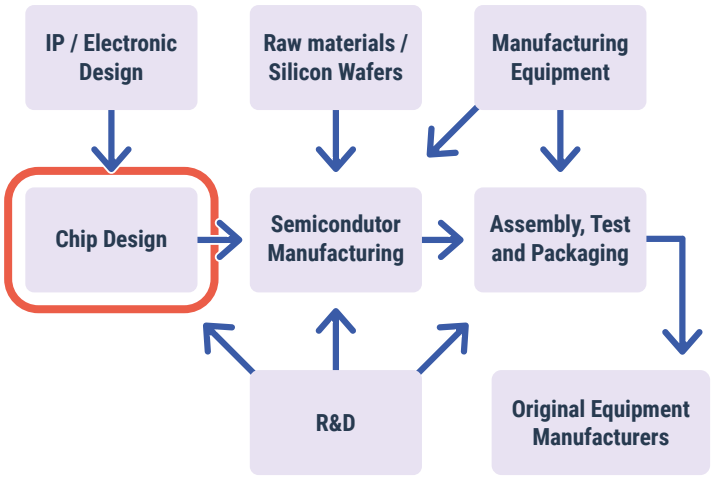
| Company | | | |
|---|---|---|---|
| ACP ADVANCED CIRCUIT PURSUIT AG | CH | SME | |
| ASYGN | FR | SME | |
| Integrated Systems Development | EL | SME | |
| XMOD TECHNOLOGIES | FR | SME | Communications |
| INRAS GMBH | AT | SME | Communications |
| EDC ELECTRONIC DESIGN CHEMNITZ GMBH | DE | SME | |
| CISC SEMICONDUCTOR GMBH | AT | SME | |
| ANSYS FRANCE SAS | FR | LE | |
| MIXED MODE GMBH | DE | SME | |
| COMCORES APS | DK | SME | |
| SECURE-IC SAS | FR | SME | |
| SYNTHARA AG | CH | SME | |

**Table: List of IC design - IP /& Electronic Design companies in the EU, along with member state headquarters, and company type.*

# SEMICONDUCTOR SUPPLY CHAIN: CHIP DESIGN

The Chip Design segment comprises companies designing their own IC chips using either IP blocks or their own proprietary design IP.

The EU companies active in this segment, by member state headquarters, company type and if in one of the two strategic sectors are:




| Companies: | | | |
|---|---|---|---|
| **eesy-ic GmbH** | DE | SME | Communications |
| **Seamless Waves** | FR | SME | Communications |
| **AICTX AG** | CH | SME | |
| **NVIDIA GmbH** | DE | LE | Communications |
| **Xilinx GmbH** | DE | LE | |

**Table: List of chip design companies in the EU, along with member state headquarters, and company type.*

The Brazilian companies involved in the Semiconductor supply chain – design sector, are the following:

| Company | Headquarters | Main site Brazil | Workforce | |
|---|---|---|---|---|
| | | | Total. | Univ. degree |
| **CADENCE** | USA | Belo Horizonte | 269 | 253 |
| **CHIPUS** | Brazil | Florianopolis | 69 | 64 |
| **EnSilica** | UK | Porto Alegre | 25 | 19 |
| **HCL Tec** | India | Campinas | 100 | 100 |
| **IMPINJ** | USA | Porto Alegre | 19 | 19 |
| **Lumentum** | USA | Campinas | 50 | 50 |
| **RFIDo** | Brazil | Belo Horizonte | 10 | 8 |
| **SILVACO** | USA | Porto Alegre | 13 | 9 |

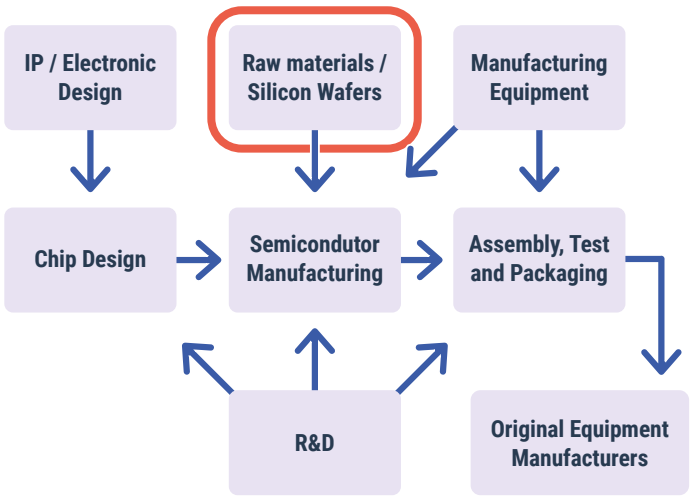
**Table: List of IC design house in Brazil, listed headquarters, main site and staff numbers*

## THE MAIN PRODUCTS AND SERVICE PRODUCED BY THE COMPANIES ARE:

- CADENCE:
  - complete set of EDA tools, system design and verification, IP development
  - local and international field services
- Chipus:
  - Mixed Signal ASICs
  - Mixed Signal IPs
  - Design Services
  - In house prototype testing
- EnSilica: Automotive tier 1s and 2s, satellite communications and industrial OEMs
- HCL: Semiconductor Engineering Services
- IMPINJ:
  - RAIN RFID Endpoint IC
  - RAIN RFID Reader IC
  - RAIN RFID Reader
  - RAIN RFID Software and services
- LUMENTUM:
  - Optical communication ASIC's (DSP, SERDES, etc)
- RFIDo:
  - services for RF, RFID, NFC and MPW IC's design
- SILVACO:
  - TCAD
  - Analog Custom Design tool
  - IP Design

# SEMICONDUCTOR SUPPLY CHAIN: RAW MATERIALS / SEMICONDUCTOR MATERIALS

Raw and manufactured materials, such as silicon wafers, photomasks, and photoresists, along with many chemicals, are necessary inputs across the semiconductor manufacturing process. Silicon wafers make up the largest portion of the materials market and a third of total semiconductor materials sales (2021).

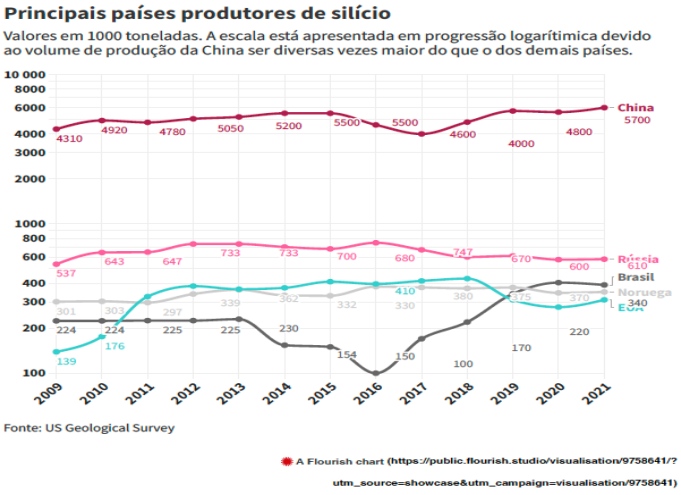



The EU companies involved in the Semiconductor supply chain – Raw Materials and Silicon Wafers segment sector, classified by company type, Large Enterprise (LE) or Small and Medium Enterprise (SME), and sector of interest (Automotive or Communications), are detailed below:

| Company | | | |
|---|---|---|---|
| SOITEC SA | FR | LE | Communications |
| SILTRONIC AG | DE | LE | |
| JSR MICRO NV | BE | LE | |
| SWEGAN AB | SE | SME | Communications |
| OKMETIC OY | FI | LE | |
| FREIBERGER COMPOUND MATERIALS GMBH | DE | LE | Communications |
| II-VI GMBH | DE | LE | |
| SAINT-GOBAIN | FR | LE | |

*Table: List of EU companies involved in the Semiconductor supply chain – Raw Materials and Silicon Wafers segment sector.*

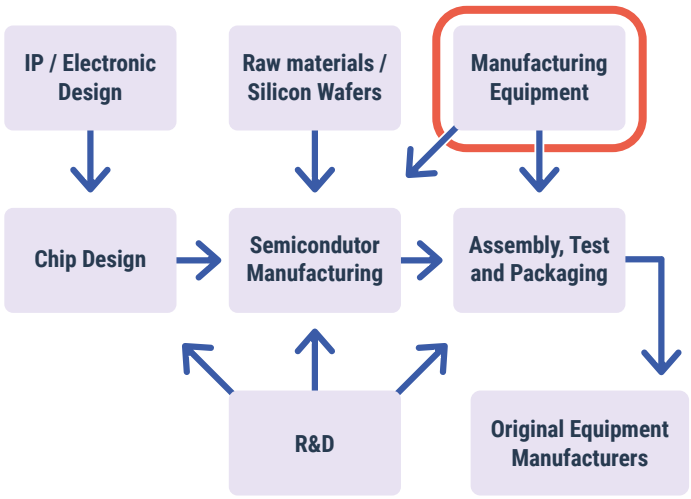
While Brazil does not have an IC raw materials and silicon semiconductor supply ecosystem for microelectronics, it is of considerable interest to note that the country is the third largest producer of Silicon in the world (for photovoltaic applications).



# SEMICONDUCTOR SUPPLY CHAIN: MANUFACTURING EQUIPMENT

A semiconductor chip fabrication process is intricate, consisting of hundreds of process steps and requires highly specialized materials inputs and manufacturing equipment to achieve the needed precision at miniature scale.

The European union is a recognised leader in the development and supply of advanced semiconductor equipment and systems.

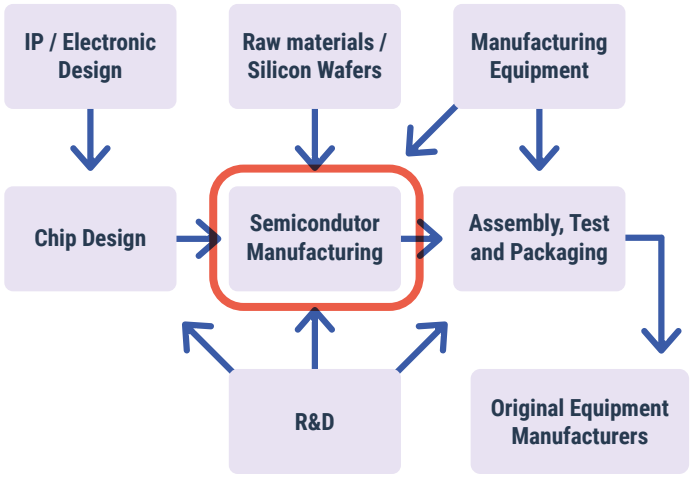



The EU companies involved in the Semiconductor supply chain – Manufacturing equipment segment, classified by company type, headquarters, and company type, Large Enterprise (LE) or Small and Medium Enterprise (SME), are detailed below:

| Company | | |
|---|---|---|
| ASML NETHERLANDS B.V. | NL | LE |
| AIXTRON SE | DE | LE |
| BESI | AT | LE |
| EV GROUP E. THALLNER GMBH | NL | LE |
| APPLIED MATERIALS | AT | LE |
| LAM RESEARCH | IT | LE |
| SPTS TECHNOLOGIES LIMITED | AT | LE |
| DISCO HI-TEC EUROPE GMBH | UK | LE |
| X-CELEPRINT LIMITED | DE | LE |
| OPTICS BALZERS JENA GMBH | IE | LE |
| Pac Tech - Packaging Technologies GmbH | DE | SME |
| SEMILAB | DE | LE |
| 3DIS TECHNOLOGIES | HU | LE |
| ADVANCED VACUUM DISTRIBUTION EUROPE AB | FR | SME |
| PFEIFFER VACUUM | SE | SME |
| SUSS MicroTec | FR | LE |
| CARL ZEISS SMT GMBH | DE | SME |
| SOLMATES BV | DE | LE |
| PVA TEPLA ANALYTICAL SYSTEMS GMBH | NL | SME |
| CENTROTHERM INTERNATIONAL AG | DE | LE |

*Table: List of EU companies involved in the Semiconductor supply chain – Equipment segment sector*

# SEMICONDUCTOR SUPPLY CHAIN: SEMICONDUCTOR MANUFACTURING




To manufacture an integrated circuit "chip" requires highly specialized semiconductor manufacturing facilities, typically called "fabs", to transfer the nano-meter scale integrated circuits from the chip design into silicon wafers. Each wafer normally contains multiple chips of the same design.

Depending on the specific product, there could be up to 1,500 steps in the overall manufacturing process of the semiconductor wafers. The average time to fabricate finished semiconductor wafers, known as the cycle time, can take up to 14-20 weeks to complete for advanced processes.

Key EU companies involved in the Semiconductor supply chain – Semiconductor Manufacturing segment, classified by headquarters, and company type, Large Enterprise (LE) or Small and Medium Enterprise (SME), are detailed below:

| Company | | | |
|---|---|---|---|
| AMS-OSRAM AG | AT | LE | AT |
| ALMAE TECHNOLOGIES | FR | SME | Communications |
| X-FAB | DE | LE | Automotive |
| UNITED MONOLITHIC SEMICONDUCTORS SAS | FR | LE | Communications |
| INFINEON TECHNOLOGIES AG | DE | LE | Automotive & Communications |
| STMICROELECTRONICS SA | FR | LE | Automotive & Communications |
| ROBERT BOSCH GMBH | DE | LE | Automotive |
| MURATA ELECTRONICS | FI | LE | Automotive |
| SEMIKRON ELEKTRONIK GMBH & CO. KG | DE | LE | Automotive |
| ELMOS Semiconductor AG | DE | LE | |

**Table: List of EU companies involved in the Semiconductor supply chain – Manufacturing segment*

This current EU semiconductor manufacturing landscape will be dramatically changed over the coming three years, triggered by the EU Chips Act and related instruments. Several recent examples of planned investments are described below.

## INTEL TO CREATE A LEADING-EDGE SEMICONDUCTOR FAB IN MAGDEBURG, GERMANY[6]

On the 15 March 2022, Intel announced the first phase of its plans invest an initial 17 billion euros into a leading-edge semiconductor fab in Germany.

To date, the German government has committed €6.8 billion ($7.5 billion) to the Intel planned builds — about 40 percent of the project's original €17 billion ($19 billion) price tag. In the initial phase, Intel plans to develop two first-of-their-kind semiconductor fabs in Magdeburg, Germany, the capital of Saxony-Anhalt. Planning has started, with construction expected to begin in 2023 and production planned to come online in 2027, pending European Commission approval. The new fabs are expected to deliver chips using Intel's most advanced, Angstrom-era transistor technologies, serving the needs of both foundry customers and Intel for Europe and globally as part of the company's IDM (integrated device manufacturer) 2.0 strategy.

## WOLFSPEED ANNOUNCES PLAN TO CONSTRUCT WORLD'S LARGEST, MOST ADVANCED SILICON CARBIDE DEVICE MANUFACTURING FACILITY IN SAARLAND, GERMANY[7]

On the 1 February 2023, Wolfspeed, the global leader in Silicon Carbide technology and production, announced plan to construct the world's largest, most advanced silicon carbide device manufacturing plant, a highly automated, cutting-edge 200mm wafer fabrication facility in Saarland, Germany.

The project is part of the Important Project of Common European Interest (IPCEI) for Microelectronics and Communication Technologies, recently approved by the European Commission (see next Section on semiconductor policy and incentives).

## INFINEON BREAKS GROUND FOR NEW SEMICONDUCTOR PLANT IN DRESDEN FOR ANALOG/MIXED-SIGNAL TECHNOLOGIES AND POWER SEMICONDUCTORS[8]

On the 2 May 2023 – Infineon Technologies AG broke ground for a new plant in Dresden together with political leaders from Brussels, Berlin and Saxony. EU Commission President Ursula von der Leyen, German Federal Chancellor Olaf Scholz, Saxony's Prime Minister Michael Kretschmer and Dresden's Mayor Dirk Hilbert symbolically launched construction work together with Infineon CEO Jochen Hanebeck.

6 https://www.intel.com/content/www/us/en/newsroom/news/eu-news-2022-release.html

7 https://www.wolfspeed.com/company/news-events/news/wolfspeed-announces-plan-to-construct-worlds-largest-most-advanced-silicon-carbide-device-manufacturing-facility-in-saarland-germany/

8 https://www.infineon.com/cms/en/about-infineon/press/press-releases/2023/INFXX202305-098.html

With an investment volume of five billion euros, the new plant is the largest single investment in Infineon's history.

This follows the initial Feb 16, 2023, announcement[9] by Infineon of a planned new Fab in Dresden for analog/mixed-signal technologies and power semiconductors. Smart Power Fab will generate 1,000 new jobs with completion planned for 2026.


The investment by Infineon strengthens the manufacturing basis for the semiconductors that drive decarbonization and digitalization. Analog/mixed-signal components are used in power supply systems, for example in energy-efficient charging systems, small automotive motor control units, in data centres and in applications for the Internet of Things (IoT). The interaction of power semiconductors and analog/mixed-signal components makes it possible to create particularly energy-efficient and intelligent system solutions

## GLOBALFOUNDRIES AND STMICROELECTRONICS ANNOUNCE AGREEMENT FOR NEW 300 MM SEMICONDUCTOR FAB IN FRANCE[10]

On the 5 June 2023 GlobalFoundries Inc. and STMicroelectronics announced the finalisation of an agreement to build a new, jointly operated, 300 mm high-volume semiconductor manufacturing facility in Crolles (France). This follows the initial communication of the project on July 11, 2022. has now been finalized, the companies said today.

The investment will create the world's largest and most advanced fabrication plant (fab) for the production of semiconductors in "FD-SOI" technology and will address the customer demand for automotive, IoT, and mobile applications over the next decades.

The initiative is expected to cost 7.5 billion euros in total, including CAPEX, maintenance, and ancillary costs.

9 https://www.infineon.com/cms/en/about-infineon/press/press-releases/2023/INFXX202302-058.html

10 https://www.powerelectronicsnews.com/globalfoundries-and-stmicroelectronics-announce-agreement-for-new-300-mm-semiconductor-fab-in-france/

## BRAZILIAN SEMICONDUCTOR MANUFACTURING ECOSYSTEM

The mapping of the Brazilian semiconductor manufacturing ecosystem revealed that there remains little silicon semiconductor fabrication capacity or capability.

| Company | Headquarter | Main site | Comment |
|---|---|---|---|
| **CEITEC** | Brazil | Porto Alegre | Fab. mothballed. CMOS fab line, 0,6 um, 150 mm diameter wafers, |
| **UNITEC** | Brazil | Rib das Neves | Fab. mothballed. |
| **SEMIKRON** | Germany | Carapicuiba | Produces power silicon devices and power modules. |
| **LUMENTUM** | USA | Campinas | Produces Photonic Integrated Circuits |

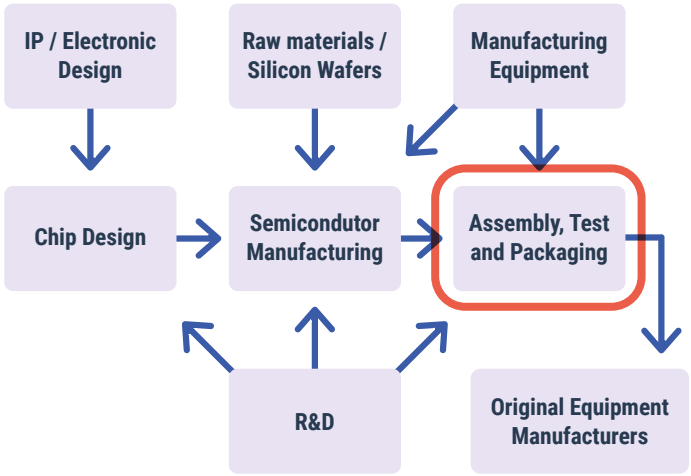
It is interesting to note that in the areas of manufacturing of photovoltaic cells, Brazil has two manufacturing companies.

| Company | Headquarters | Main site | Comment |
|---|---|---|---|
| **BYD** | China | Campinas | Produces Silicon solar panels. |
| **SUNEW** | Brazil | Belo Horizonte | Produces Organic Photovoltaics (OPV) with installations implanted in over 16 countries. |

# SEMICONDUCTOR SUPPLY CHAIN: ASSEMBLY, TEST AND PACKAGING (ATP)

This stage involves converting the silicon wafers produced by the fabs into finished chips that are ready to be assembled into electronic devices.

Companies involved at this stage first slice silicon wafers into individual chips. Chips can then be packaged into protective frames and encased in a resin shell. Alternatively, chips are assembled on wafer and subsequently protected. Chips are normally rigorously tested before being shipped to electronic device manufacturers.



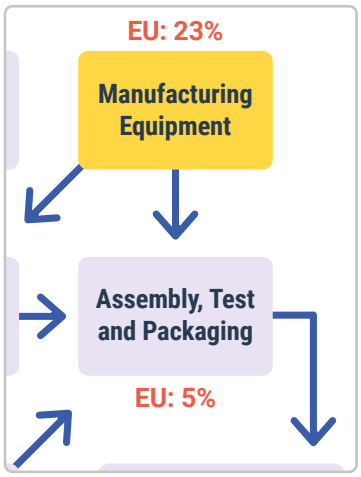

Key EU companies involved in the Semiconductor supply chain – Assembly, Test and Packaging (ATP) segment, classified by headquarters, company type (Large Enterprise (LE) or Small and Medium Enterprise (SME)) and strategic sector, are detailed below:

| Company | | | |
|---|---|---|---|
| ATEP - AMKOR TECHNOLOGY PORTUGAL SA | PT | LE | Automotive |
| ROODMICROTEC GMBH | DE | SME | Automotive, Communications |
| SENCIO BV | NL | SME | |
| AFORE OY | FI | SME | |
| PACKAGING SIP | FR | SME | |
| WURTH ELEKTRONIK GMBH & CO KG | DE | LE | Automotive, Communications |
| AT & S AUSTRIA TECHNOLOGIE & SYSTEMTECHNIK AKTIENGESELLSCHAFT | AT | LE | |
| FEI ELECTRON OPTICS BV | NL | LE | |
| DEMCON ADVANCED MECHATRONICS BV | NL | SME | |
| FABMATICS GMBH | DE | SME | |
| BRUKER AXS GMBH | DE | LE | |
| NOVA MEASURING INSTRUMENTS LTD | DE | LE | |
| BENETEL LIMITED | IE | SME | Communications |
| BOSCHMAN TECHNOLOGIES BV | NL | SME | |
| Advantest Europe GmbH | DE | LE | |
| EDA Industries Spa | IT | SME | |
| ITEC BV | NL | SME | |
| ICOS VISION SYSTEMS NV | BE | LE | |

*Table: List of EU companies involved in the Semiconductor supply chain – ATP segment*

Despite the number of EU companies cited above in this segment of assembly, test and packaging of chips, within the EU, this activity has been traditionally outsourced to East Asia, with the result that the EU holds less than 5% of the global ATP market share.

However, this EU positioning in the ATP segment of the semiconductor value chain is now changing significantly under the imputus of the EU Chips Act. In particular, in the advanced packaging segment of strategic importance to EU Automotive and Communications value chains. Three examples are provided below:




## EXPANSION OF THE ONLY HIGH-VOLUME, ADVANCED PACKAGING, TIER 1 OSAT IN EUROPE (AMKOR, PORTO, PORTUGAL)[11],

In October 2022, Amkor, one of the world's largest providers of outsourced semiconductor packaging and test services (OSAT) providers of semiconductor packaging and test services, and the only high-volume, advanced packaging, Tier 1 OSAT in Europe, announced an expansion of its facilities in Porto, Portugal, to Support the European Semiconductor Ecosystem and in particular the semiconductor automotive sector.

## CREATION OF FIRST AT-SCALE SEMICONDUCTOR TEST AND ASSEMBLY SERVICES (OSAT) IN EUROPE[12]

On the 16 February 2023 Amkor Technology, Inc. a leading provider of semiconductor packaging and test services, and GlobalFoundries, a global leader in semiconductor manufacturing, announced today that the two companies have formed a strategic partnership to enable a comprehensive EU/US supply chain from semiconductor wafer production at GF to OSAT* services at Amkor's site in Porto, Portugal. GF plans to transfer its 300mm Bump and Sort lines from its Dresden site to Amkor's Porto operations to establish the first at-scale back-end facility in Europe. The objective to enables the first semiconductor manufacturing (foundry) through advanced packaging semiconductor supply chain outside of Asia, creating more European supply chain autonomy for key end markets including automotive.

11 Amkor Leverages Its Global Automotive Leadership to Support European Semiconductor Ecosystem
TEMPE, Ariz.–(BUSINESS WIRE)--Oct. 24, 2022-- Amkor Technology, Inc. (Nasdaq: AMKR), a leading provider of semiconductor packaging and test services, today announced its commitment to supporting European initiatives to achieve strategic regionalization for automotive semiconductors.

12 Amkor Technology and GlobalFoundries to Provide At-scale Semiconductor Test and Assembly Services in Europe, 02/16/2023, Marketscreener,
https://www.marketscreener.com/quote/stock/GLOBALFOUNDRIES-INC-128691269/news/GLOBALFOUNDRIES-Amkor-Technology-and-GlobalFoundries-to-Provide-At-scale-Semiconductor-Test-and-As-43010792/

## INTEL ANNOUNCES THE ESTABLISHMENT OF A CUTTING-EDGE SEMICONDUCTOR ASSEMBLY AND TEST FACILITY IN POLAND[13].

On the 16 June 2023, Intel announced the construction of a cutting-edge semiconductor assembly and test facility in Wroclaw, Poland, allowing the creation a first-of-its-kind end-to-end leading-edge manufacturing semiconductor value chain in Europe.

The advanced ATP facility will help meet critical demand for assembly and test capacity that Intel anticipates by 2027. Intel expects to invest up to $4.6 billion in the facility, which, when completed, will support approximately 2,000 Intel employees.

The announcement states that the investment will help the European Union work toward its goal of a more resilient semiconductor supply chain.

**Note:** From a strategic EU viewpoint, the initiative in Poland joins Intel's other manufacturing projects in the EU: expansion of the facility in Leixlip, Ireland and a new front-end facility in Magdeburg, Germany.

The Brazilian companies involved in the Semiconductor supply chain – assembly, test and packaging segment are the following:

| Company | Headquarter | Main site | Total Area | Clean Room | Workforce | | |
|---|---|---|---|---|---|---|---|
| **IC Packaging** | | Brazil | $m^2$ | $m^2$ | Total | Univ degree | R&D |
| **ADATA** | Taiwan | Ant Posse | 7.500 | 3.000 | 150 | 60 | 12 |
| **CAL-COMP Ind de Semicondutores S.A** | Taiwan | Manaus | | | | | |
| **Hana Micron** | South Korea | S Leopoldo | | 10.000 | 265 | 120 | |
| **Brasil Componentes** | Brazil | Extrema | | 560 | 52 | 26 | |
| **Smart Modular** | USA | Atibaia | 19.000 | | 512 | 221 | 10 |

**Table: List of IC packaging companies in Brazil, the corresponding headquarter and some indicators*

The main products produced by the companies include:

- DRAM/LPDRAM
- NAND Flash Memory
- eMMC/UFS
- eMCP/uMCP
- Memory modules
- Solid State Drives - SSD

13 Intel Plans Assembly and Test Facility in Poland, https://www.businesswire.com/news/home/20230616988094/en/

ABISEMI (Brazilian Semiconductor Association) has estimated annual revenues for the sector of the order of USD 4.5 billion (2022).

**Note:** Outside of East Asia, Brazil retains the largest hub on IC packaging, offering Outsourced semiconductor assembly and test (OSAT).

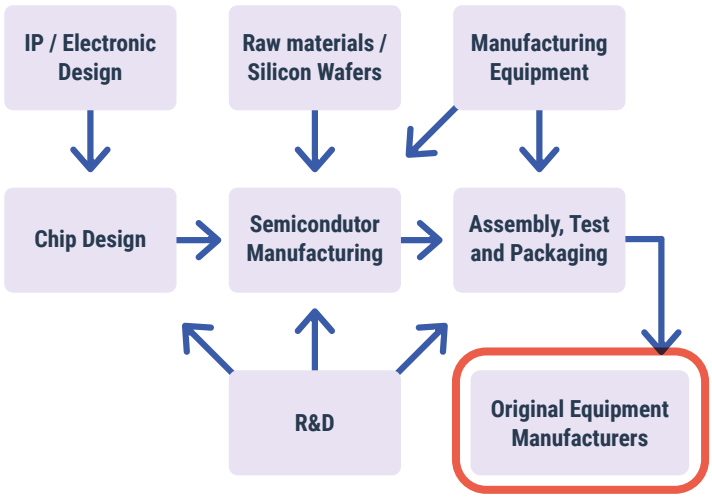
OSATs provide assembly, packaging and test services under contract to both IDMs and fabless companies. This part of the supply chain was first offshored by some US IDMs starting back in the 1960s because of its lower capital intensity and the need for lower-skilled labour. The fabless-foundry model then also led to the emergence of specialized OSAT companies.

Given the current geopolitical climate, there is a potential opportunity for Brazil to become a global OSAT service centre.

# SEMICONDUCTOR SUPPLY CHAIN: ORIGINAL EQUIPMENT MANUFACTURERS (OEMS)

An original equipment manufacturer (OEM) usually refers to a company that builds a product designed for end-users, like a car, a PC, or a telephone. printer.

Key research active EU companies involved in the Semiconductor supply chain – Original Equipment Manufacturers (OEMs) segment, classified by headquarters, company type (Large Enterprise (LE) or Small and Medium Enterprise (SME)) and strategic sector, are detailed below:




| Company | | | |
|---|---|---|---|
| NOKIA SOLUTIONS AND NETWORKS GMBH &CO KG | DE | LE | Communications |
| ERICSSON AB | SE | LE | Communications |
| TESAT-SPACECOM GMBH & CO.KG | DE | LE | Communications |
| THALES SIX GTS FRANCE SAS | FR | LE | Communications |
| SIAE MICROELETTRONICA SPA | IT | LE | Communications |
| THALES ALENIA SPACE ESPANA, SA | ES | LE | |
| PHILIPS ELECTRONICS NEDERLAND B.V. | NL | LE | |
| ALSEAMAR | FR | LE | |
| Atlas Copco Industrial Technique AB | SE | LE | |
| ZF FRIEDRICHSHAFEN AG | DE | LE | Automotive |
| MELEXIS GMBH | DE | LE | |
| VALEO SYSTEMES DE CONTROLE MOTEUR SAS | FR | LE | Automotive |
| DAIMLER AG | DE | LE | Automotive |
| SICK AG | DE | LE | Automotive |
| LEONARDO - SOCIETA PER AZIONI | IT | LE | |
| FAGOR ARRASATE S COOP | ES | LE | |
| SIEMENS AKTIENGESELLSCHAFT | DE | LE | Automotive |
| DEVOLO AG | DE | LE | |
| Enel S.p.A. | IT | LE | |
| TELEVES SA | ES | LE | |

**Table: List of EU companies involved in the Semiconductor supply chain – OEM segment*

## ORIGINAL EQUIPMENT MANUFACTURERS (OEMS): AUTOMOTIVE SECTOR

The European Union is a world leader in the world-wide Automotive OEM sector with four headquartered companies in the top ten car OEMs ranked by their revenue (2022: Q1, Q2, Q3). These 10 car OEMs dominate the global market and lead the way in terms of innovation, sustainability, and electrification.

| Rank | Name | Revenue | Country |
|---|---|---|---|
| 1 | Volkswagen | $306.89 B | Germany |
| 2 | Toyota | $273.29 B | Japan |
| 3 | Ford | $165.05 B | USA |
| 4 | General Motors | $160.74 B | USA |
| 5 | Mercedes-Benz | $157.96 B | Germany |
| 6 | BMW | $155.37 B | Germany |
| 7 | Honda | $124.33 B | Japan |
| 8 | Hyundai | $113.71 B | S. Korea |
| 9 | SAIC Motor | $109.77 B | China |
| 10 | Stellantis 14 | $101.32 B | Netherlands |

14 Stellantis was created in January 2021 through the merger of two major car manufacturers: Fiat Chrysler Automobiles and PSA Group. Its portfolio includes well-known brands such as Jeep, Dodge, Chrysler, Peugeot, Citroen, and Opel.

European automotive OEMs are equally present in the Automotive Supply Chain in Brazil, as shown in the table of automobile producers below (revenue 2022[15]).

| # | Make | Estimated revenue (R$ Billions) | # vehicules sold in 2022 |
|---|---|---|---|
| 1 | FIAT | R$45,30 | 429.591 |
| 2 | TOYOTA | R$39,00 | 191.109 |
| 3 | CHEVROLET | R$37,70 | 291.036 |
| 4 | VOLKSWAGEN | R$31,40 | 271.013 |
| 5 | JEEP | R$26,60 | 137.339 |
| 6 | HYUNDAI | R$19,70 | 187.651 |
| 7 | RENAULT | R$12,50 | 125930 |
| 8 | NISSAN | R$8,20 | 53.587 |
| 9 | HONDA | R$7,50 | 56.622 |
| 10 | CHERY | R$6,20 | 34.997 |
| 11 | MITSUBISHI | R$6,00 | 22.580 |
| 12 | BMW | R$5,60 | 13.765 |
| 13 | FORD | R$5,40 | 19.840 |
| 14 | PEUGEOT | R$4,70 | 41.657 |
| 15 | CITROEN | R$3,70 | 32.048 |
| 16 | MERCEDES | R$3,30 | 8.833 |
| 17 | AUDI | R$2,30 | 5.482 |
| 18 | PORSCHE | R$2,20 | 3.232 |
| 19 | VOLVO | R$2,20 | 5.267 |
| 20 | LAND ROVER | R$2,00 | 3.653 |

This EU automotive OEM dominance is also reflected in the Tier-1 suppliers present in Brazil[16].

| Company | Headquarters |
|---|---|
| **Bosch,** | Germany |
| **Continental** | Germany |
| **Visteon** | USA |
| **Hella** | Germany |
| **Valeo** | France |
| **Denso** | Japan |
| **Wahler** | Germany |
| **Borgwarner** | USA |
| **Delphi,** | USA |
| **Kostal** | Germany |

**Table: Brazilian Automotive Industry Tier-1 suppliers*

15 https://www.car.blog.br/2023/02/ranking-das-montadoras-brasileiras-por.html

16 Osvaldo Correa, CEO, Flex IC Microelectronic Industry

## ORIGINAL EQUIPMENT MANUFACTURERS (OEMS): TELECOMMUNICATIONS SECTOR

The EU has two OEMs, Nokia and Ericsson, amongst the global top five telecom equipment[17] OEM vendors: Huawei, Nokia, Ericsson, ZTE and Cisco.

However, Huawei's position as number 1 comes largely, but not exclusively, from its leading position in China, where the major operators have been investing heavily in 5G and fibre access networks in recent years and have been handing much of the work to the domestic vendor duo of Huawei and ZTE.

Outside China, EU telecom equipment OEMs clearly lead, with Nokia, Ericsson and then Huawei[18] the top three telecom equipment vendors in 2022, with market shares of 20%, 18% and 18% respectively (Telecom TV, Mar 22, 2023).

EU OEMs are equally present in the telecom equipment OEM Tier 1 supplier landscape in Brazil, with two EU OEM's in the top five.

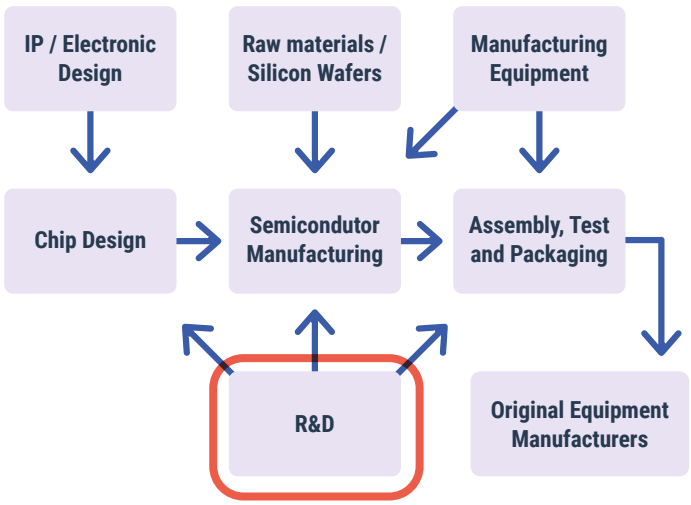
| Ranking | Company |
|---|---|
| 1 | Nokia |
| 2 | Huawei |
| 3 | Ericson |
| 4 | Cisco |
| 5 | WDC Networks |

17 Equipment includes Broadband Access, Microwave & Optical Transport, Mobile Core Network & RAN, SP Router & Switch

18 Huawei's share outside China will likely shrink further in the coming years as pressure weighs in key markets such as Germany, where the Chinese vendor is still very active but now faces a potential ban.

# SEMICONDUCTOR SUPPLY CHAIN: RESEARCH & DEVELOPMENT (R&D)

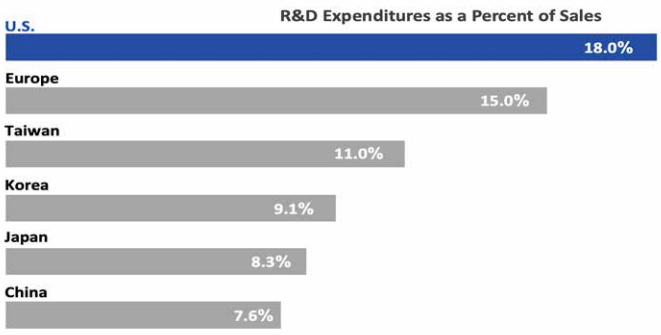
## BACKGROUND




About 56% of the global semiconductor industry R&D spending in 2021 came from companies headquartered in the Americas, basically all of which were U.S. companies, with 19% coming from Intel.

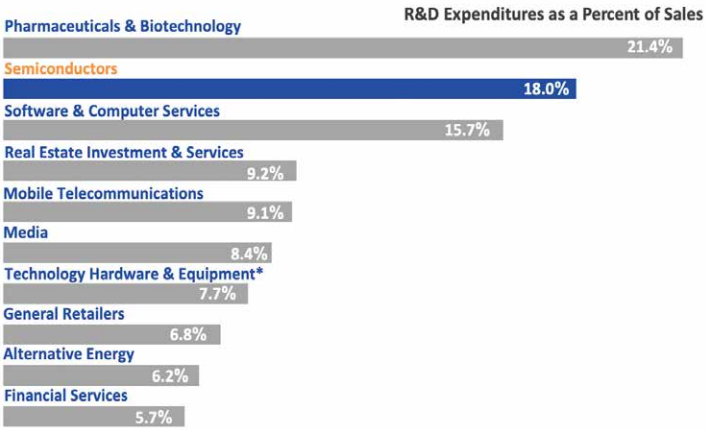
In 2021 Asia-Pacific companies (including foundries, fabless, and IDMs) spent more than 29% of the global total on semiconductor R&D, followed by European companies with 8% and Japan with approximately 7% of industry spending.

The semiconductor industry's R&D spending as a percent of sales is shown opposite by competitor blocks.




It is seen that the EU R&D expenditure is globally second in the world and well ahead of that of Taiwan, Korea and Japan[19].

The rate of U.S. semiconductor industry R&D spending is among the highest in key major high technology industrial sectors. Based on the 2021 EU Industrial R&D Investment Scoreboard, the U.S. semiconductor industry was second only to the U.S. pharmaceuticals & biotechnology industry in terms of the rate of R&D spending as a percent of sales.




Total R&D spending by semiconductor companies is expected to rise by a compound annual growth rate (CAGR) of 5.5 percent between 2022 and 2026 to $108.6 billion[20].

19 The 2021 EU Industrial R&D Investment Scoreboard.

20 https://www.icinsights.com

It is clear that the semiconductor industry dominates and will remain the major source of semiconductor R&D spend (as compared to public R&D support).

## EUROPEAN UNION SEMICONDUCTOR R&D ACTORS

The EU semiconductor sector is characterised by intense R&D activity, with leading companies reinvesting more than 15% of their revenues into research in next generation technologies, as shown in the graphic above. The EU is home to world-leading research and technology organisations and many excellent universities and research institutes spread across the Union. These are pioneering the techniques behind the production of some of the world's most advanced chips, in areas where EU OEMs lead.

For example, the EU is strong in the design of semiconductor components for power electronics, radio frequency and analogue devices, sensors and microcontrollers that have a widespread use in the automotive and manufacturing industries today. It is less strong in the design of digital logic (processors and memory), where the EU does not have a leading semiconductor industry[21].

EARTO (European Association of Research and Technology Organisations) counts over 350 RTOs in more than 32 countries, with some having some element of semiconductor R&D activity. It is beyond the scope of this mapping to explore this broad landscape in any detail. This mapping exercise rather highlights key elements of the EU R&D landscape to provide a compass to further reflection and contact.

The starting point is that three of the world's leading global semiconductor research institutions are located in the EU. All have 300mm fabrication lines and capability. The Interuniversity Microelectronics Centre (IMEC) in Belgium is an international innovation hub in nanoelectronics, semiconductors and other digital technologies. CEA-LETI in France is one of the world's largest research institutes for applied research in microelectronics and nanotechnology. Finally, the Fraunhofer-Gesellschaft in Germany is one of the world's leading application-oriented research organization, with its largest institute dedicated to microelectronic and information technology system solutions and services.

A second circle is those research institutions with 200mm fabrication lines. These include Silicon Austria, Tyndall Institute Ireland and VTT Finland.

At a broader level, and to facilitate new linkages between Brazilian and European regions, Silicon Europe unites the strongest European semiconductor clusters in an alliance with access to advanced technologies and expertise in all fields of the semiconductor value chain.

Silicon Europe today consists of ten renowned European clusters who have joined forces to support Europe's goal to be the world's leading centre for innovative semiconductor technologies.


21 https://www.european-chips-act.com

The ten clusters are: GAIA, High Tech NL, Mesap, MIDAS, Minalogic, Mobile Heights, SCS Cluster, Silicon Alps, Silicon Saxony and TICE.PT

The most active RTO's and universities involved in the EU flagship RDI programme for semiconductors, the Key Digital Technologies Joint Undertaking (KDT JU), in specific segments of the value chain, are detailed below:

| Area | Organisation | Country | Type | Field |
|---|---|---|---|---|
| **Semiconductor materials, processes and technologies** | INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM | BE | RTO | Process, characterisation |
| | UNIVERSITATEA POLITEHNICA DIN BUCURESTI | RO | UNIV | Characterisation |
| | COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES | FR | RTO | Process, characterisation |
| | FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. | DE | RTO | Process, characterisation |
| | NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO | NL | RTO | Contamination control technology |
| | UNIVERSITEIT TWENTE | NL | UNIV | Active EUV mirror control |
| | IHP GMBH - INNOVATIONS FOR HIGH PERFORMANCE MICROELECTRONICS/ LEIBNIZ-INSTITUT FUER INNOVATIVE MIKROELEKTRONIK | DE | RTO | HBT and BiCMOS |
| **Automotive or Communications** | TECHNISCHE UNIVERSITAET DRESDEN | DE | UNIV | Digital baseband |
| | LUNDS UNIVERSITET | SE | UNIV | Digital baseband |
| | III-V LAB | FR | RTO | Compound epitaxy, devices |
| | COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES | FR | RTO | mm Wave FOWLP |
| | TECHNISCHE UNIVERSITEIT EINDHOVEN | NL | UNIV | Low-latency wireless connections, Battery management, Electro-magnetic suspension and energy harvesting |
| | TECHNISCHE UNIVERSITEIT DELFT | NL | UNIV | High-performance embedded computing platform |
| | VIRTUAL VEHICLE RESEARCH GMBH | AT | RTO | Edge perception and edge vehicle intelligence |
| | VYSOKE UCENI TECHNICKE V BRNE | CZ | UNIV | Sensing and data fusion platform for localisation and local 3D map building |
| | TECHNISCHE UNIVERSITAET MUENCHEN | DE | UNIV | Formal verification of analog/ mixed-signal circuits; Robust motion planning |
| | Teknologian tutkimuskeskus VTT Oy | FI | RTO | Multi-sensor fusion |
| | INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM | BE | RTO | High-resolution radar sensors and vision cameras |
| | AGENCIA ESTATAL CONSEJO SUPERIOR DEINVESTIGACIONES CIENTIFICAS | ES | RTO | Driver Monitoring System |

## BRAZILIAN SEMICONDUCTOR R&D ACTORS

### BRAZILIAN R&D CENTRES

The key Brazilian R&D centres with activities on semiconductors in Brazil are listed below by affiliation, main site, clean room area, workforce and revenue[22]. They are described in Annex A.

| R&D Centers | Affiliation | Main site | Total Area | Cleanroom | Workforce | | | Revenues |
|---|---|---|---|---|---|---|---|---|
| | | | m² | m² | Total | PhD | MSc | US$ |
| **CBPF-LABNano** | MCTI | Rio de Janeiro | | | | | | |
| **CTI** | MCTI | Campinas | 2000 | 950 | 47 | 34 | 7 | 5 |
| **IBTI** | Private | Brasília | | | | | | |
| **ISI Micro-eletrônica** | SENAI | Manaus | | | | | | |
| **Instituto Eldorado** | Private | Campinas | | 300 | | | | |
| **ITT Chip** | UNISINOS | S. Leopoldo | 2.500 | 750 | 50 | 9 | 11 | 0,6 |
| **LNNano** | MCTI | Campinas | | 200 | 32 | 18 | 7 | 2 |
| **Oninn (CSEM Brasil)** | Private | Belo Horizonte | | | | | | |
| **Von Braun** | Private | Campinas | | | | | | |

**Table: List of main Brazilian R&D centres in the field of semiconductors*

### UNIVERSITY RESEARCH AND TRAINING: SEMICONDUCTOR UNIVERSITY MICROFABRICATION LABS:

The Table below contains a list of universities and respective labs with micro/nanofabrication facilities and clean rooms.

| University | Lab name | Main topics | Clean room area m² | INCT Member |
|---|---|---|---|---|
| **PUC-RJ** | LabSem | III-V materials and devices, MOVPE growth | ~100 | DISSE |
| **PUC-RS** | NT-Solar | Si Solar Cells, pilot line | 210 | |
| **UFMG** | LNS | III-V, Si, 2D, MBE growth, Nanodevices, sensors | ~150 | DISSE |
| **UFMG** | LPCNano | Materials, processes and nanodevices | 120 | NANOCARBONO |
| **UFRGS** | LME | CMOS, sensors, defects, organic electronics | ~200 | NAMITEC |
| **UNICAMP** | CCSNano | Si technologies, sensors, carbon nano, PIC | ~500 | NAMITEC |
| **UNICAMP** | LPD | III-V materials, CBE growth, PIC, optoelectronics | ~100 | NAMITEC |
| **USP** | LME | Microfabrication, CMOS, MEMS, a-Si | ~300 | INOE |
| **USP** | LSI | CMOS/SOI, MEMS, Sensors, Nanofabrication | ~150 | NAMITEC |
| **USP** | LNMS | MBE growth, spintronics, III-V materials | ~100 | DISSE |
| **USP** | PO | Polymers, Organic semiconductor device | | INEO |

22 Not all R&D centers replied to the questionnaire issued by the Brazilian expert, while others did not include some details.

Among these labs are 4 working on silicon microelectronics devices and fabrication: LME/UFRGS, CCS-Nano/UNICAMP, LME/USP and LSI/USP. CNPq organized a programme called INCT (Institutos Nacionais de Ciência e Tecnologia) to finance R&D&I networks. Most of the microfabrication labs are member of an INCT, as indicated in the table. Each INCT has of the order of 100 members belonging to 10 to 20 different institutions and also international collaborators, including from the EU.

The INCT leading institutions are as follows:

- DISSE – NanoDISpositivos SEmicondutores, PUC-RJ, RJ
- INOE – Instituto Nacional de Eletrônica Orgânica, IFSC/USP, SP
- NAMITEC – Nano e Microeletrônica para Tecnologias Habilitadoras, FEEC/UNICAMP
- NANOCARBONO – Nanomateriais de Carbono, DF/UFMG, MG

These groups do research on materials, devices, modelling, noise, fabrication processes and applications[23].

## IC DESIGN AND EDA TOOL DEVELOPMENT:

The number of institutions working on IC design and EDA tool development is much larger that the institutions working on materials and device fabrication. An overview of these institutions can be seen from the APCI (Apoio a Projeto de Circuitos Integrados em Universidades) program organized by SBMicro (Brazilian Microelectronics Society) and detailed at https://sbmicro.org.br/programas/apci and financed by CNPq.

The table in Annex B lists the universities, number of associated professors, PhD students and masters students linked to this program (some 211 professors, 138 PhD students and 192 Master students). The program finances EDA tools for the universities and also ASIC fabrication prototyping at foundries through the Europractice service. There is thus considerable capacity for training of students and research on IC design in Brazil.

## EDA TOOL DEVELOPMENT

The number of Brazilian institutions working on EDA tool development is much smaller compared to those working on IC design. The main institutions are UFRGS, UFSC, UFPel and UFMG. UFRGS and UFMG have generated two “spin-offs”; Nangate-UFRGS Research Lab and Jasper respectively. Nangate-UFRGS was acquired by SILVACO. whilst Jasper acquired by CADENCE. These are now the local sites of SILVACO and CADENCE in Brazil.

23 The materials include Silicon, SiC, III-V, organic and Perovskita semiconductors, carbon nanotubes, graphene and other 2D layers, high K dielectrics, among others. Devices include FinFET, SOI transistors, All Gate around transistors, junction-less transistors, tunnel FET, bio-FET, many type of sensors, IR and X-ray detectors, photonic devices, photovoltaic cells and others.

The fabrication facilities and processes include e-beam lithography, optical lithography, plasma etching, ion-implantation, CVD, MBE, CBE, OMCVD, LPCVD, PECVD, oxidation and diffusion furnaces, microfluidics, FIB, high resolution SEM and so on.

Work on modeling includes atomistic simulation, finite element simulation, processes and device simulation, noise modeling and compact modeling.

Also, a complete set of electrical and optical characterization equipment are available and used at different institutions.

# 4 A REVIEW OF SEMICONDUCTOR SECTOR POLICY INSTRUMENTS AT BRAZILIAN AND EUROPEAN UNION LEVEL

The objective in this part of the report is to provide a concise review of Brazilian and EU[24] level initiatives, their plans and acts for supporting and strengthening their semiconductor industry ecosystems, positioned in the context of their specific visions and ambitions for this decade.

## BRAZILIAN SEMICONDUCTOR SECTOR POLICY INSTRUMENTS

The key Brazilian Policy Instruments in the Semiconductor Sector, along with those for the Automotive and Communications sectors are:

- PADIS (Support Program for the Technological Development of the Semiconductor Industry),
- the ICT Law (Informatics and Communication Law) for companies in the information and communication technologies (ICT) sector,
- the Rota 2030 (Route 2030) Law 13.755/18 for support of companies in the automotive sector and
- the Lei do Bem (Good Will) - Law 11.196/05 which supports all companies across all sectors performing technological innovation.

24 Note: It is not possible within the scope and budget of this Technical Study to review the individual policies or fiscal framework of the 27 individual EU member states or even less so, the policies of each of the 242 major EU regions at NUTS 2 level (NUTS - Nomenclature of territorial units for statistics).

## PADIS – LAW 11.484/2007, UPDATED BY 14.302/22 AND REGULATED BY DECREE 14.302 ON MARCH 28, 2023

PADIS - Support Program for the Technological Development of the Semiconductor Industry - is part of the industrial public policies and science, technology and innovation (ST&I) to support, under the terms of the aforementioned Law and its regulation, legal entities (companies) that invest in research, development and innovation (RD&I) in the sectors of semiconductors and displays.

**Objective:** is for Brazil to become a player in IC design, fabrication, packaging and test

**Validity:** until Dec 31, 2026

The programme covers:

- Semiconductors
- Display
- Solar PV
- LED (solid-state lightening)

The Benefits and Incentives include:

- CIDE (Contribution for Intervention in the Economic Domain)
  - Reduction to zero
  - Technology transfer, patent exploitation, use of trademarks, provision of technical assistance
- Financial credit - R&DI multiplied by 2.62, limited to 13.12% of the calculation basis
- Compensation of federal tributes, taxes and contributions
- Income tax
  - Reduction to zero

The Term for benefits and incentives is between 12 years (for CIDE and IRPJ taxes) and 16 years (for Foundries and Design Houses).

The company must make investments of 5% of turnover in R&D

Establishes IC Topography Protection Regime (some details?)

The web page of MCTI lists 13 companies approved as beneficiaries of PADIS[25]. More details are available[26]

25 https://inovacaodigital.mcti.gov.br/padis/empresas-habilitadas-produtos-aprovados/pesquisarEmpresashabilitadas;jsessionid=F9D1182395D953EAF5993A40187F20A4?ufSelecionada=Todas&municipio=

26 More details at https://www.in.gov.br/en/web/dou/-/lei-n-14.302-de-7-de-janeiro-de-2022-372798229 and https://www.in.gov.br/en/web/dou/-/decreto-n-11.456-de-28-de-marco-de-2023-473390191

| | Corporate name[27] | Short Name |
|---|---|---|
| 1 | ADATA INTEGRATION BRAZIL S/A | AI SEMICONDUTORES |
| 2 | BRPHOTONICS PRODUTOS OPTOELETRONICOS S/A | BRPHOTONICS PRODUTOS |
| 3 | BYD ENERGY DO BRASIL LTDA. | BYD |
| 4 | CAL-COMP INDUSTRIA DE SEMICONDUTORES S.A | CAL-COMP |
| 5 | CENTRO NACIONAL DE TECNOLOGIA ELETRÔNICA AVANÇADA S.A | CEITEC |
| 6 | CHIPUS MICROELETRÔNICA SERVIÇOS DE ENGENHARIA ELÉTRICA LTDA | CHIPUS MICROELETRÔNICA |
| 7 | HT MICRON SEMICONDUTORES S.A. | HT MICRON |
| 8 | Idea Sistemas Eletronicos Ltda - Epp | Idea Sistemas |
| 9 | MULTILASER INDUSTRIA DE EQUIPAMENTOS DE INFORMATICA, ELETRONICOS E OPTICOS LTDA | MULTILASER INDUSTRIA DE EQUIPAMENTOS |
| 10 | PURE ENERGY GERACAO DE ENERGIA LTDA | PURE ENERGY |
| 11 | S4 SOLAR DO BRASIL LTDA | S4 SOLAR |
| 12 | Smart Modular Technologies Indústria e Componentes Ltda | Smart Modular Technologies Indústria e Componentes |
| 13 | SUNEW FILMES FOTOVOLTAICOS IMPRESSOS S.A. | SUNEW FILMES |

## ICT LAW (INFORMATICS AND COMMUNICATION LAW)

This law[28] was first stablished in 1991 as Law 8.248/91 and was up-dated on December 2019 under Law 13.969/19. It establishes incentives for companies with investments in research, development and innovation (RD&I) activities, related to the information and communication technologies (ICT) sector.

**Validity:** until Dec 31, 2029

**Benefits:**

- Financial credit - R&DI multiplier, limited to 10,92% to 13.65% of the calculation basis depending on the region of production
- Compensation of federal tributes, taxes and contributions (IPI, IRPJ, CSLL, PIS, COFINS)

**Company must make:**

- Investments of 4% of turnover in R&D
- Comply with PPB requirements

27 Some company names in the list changed names and/or ownership. BRPhotonics Products was sold to Lumentum, Idea Sistemas was sold to Lumentum, HT Micron is now Hana Micron and Multilaser Industria de Equipamentos changed name to Grupo Multi and is owner of the company Brasil Componentes

28 https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/lei-de-tics

The MCTI web page lists 509 companies[29] beneficiaries of ICT Law[30].

PPB: The PPB consists of the minimum necessary manufacturing steps that companies must comply with to manufacture a given product as a counterpart to the tax benefits established by law. The PPB requirements are established through Interministerial Ordinances31, signed by the Ministers of Development, Industry and Commerce (MDIC) and Science, Technology and Innovations (MCTI).

Each product has its own ordinance that contains a series of productive stages, with each manufacturing stage allocated a specific score. The company must meet a minimum score established in the ordinance for that product.

## ROTA 2030 – LAW 13.755/18

The **Route 2030** program was established by Decree n. 9557 of November 8, 2018, which establishes mandatory requirements for the sale of vehicles in the country, institutes the Rota 2030 Program – Mobility and Logistics and provides for the tax regime for non-produced auto parts.

There are many companies working on R&D projects with support of this program as described in the report[32] of 2022, pages 23 until 43.

## LEI DO BEM (GOOD WILL) - LAW 11.196/05

This law[33] created on the 21 November 2005, and regulated by Decree No. 5,798, of the 7 June 2006, established tax benefits for technological innovation.

This Law establishes tax incentives that companies can automatically enjoy, provided they carry out technological research, development and innovation. These incentives represent between 20.4% to 34% of expenditures on RDI projects.

29 https://inovacaodigital.mcti.gov.br/leiDeInformatica/empresasHabilitadas/pesquisarEmpresashabilitadas?ufSelecionada=Todas&municipio=

30 Note: Many companies are beneficieries several times since the inception of the programme and thus listed several times. The actual number of beneficieries are much less

31 https://antigo.mctic.gov.br/mctic/opencms/legislacao/portarias_interministeriais/Portaria_Interministerial_SEPEC_ME_SEXEC_MCTIC_n_46_de_09102019.html

32 https://inovacaodigital.mcti.gov.br/leiDeInformatica/empresasHabilitadas/pesquisarEmpresashabilitadas?ufSelecionada=Todas&municipio=

33 https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/lei-do-bem and https://www.sogedev.com.br/servicos-incentivos.php?creative=562394121241&keyword=lei%20do%20bem&matchtype=b&network=g&device=c&utm_source=(creative)&utm_medium=(network)&utm_term=(keyword)&utm_content=(device)&utm_campaign=(campaignid)

**The tax benefits are:**

- Additional exclusion of 60% to 100% of RD&I expenditures from the IR (25%) and CSLL (9%) calculation base,
- 50% reduction of IPI,
- Full depreciation, in the same year of acquisition, of new machinery, equipment, devices and instruments,
- Accelerated amortization, by deduction as a cost or operating expense, in the calculation period in which they are made,
- Reduction to 0 (zero) of the withholding income tax on remittances made abroad for the registration and maintenance of trademarks and patents.

Technological innovation projects must be framed in the following concept, established by Brazilian legislation: "Conception of a new product or manufacturing process, as well as the addition of new functionalities or characteristics to the product or process that implies incremental improvements and effective gain in quality or productivity, resulting in greater competitiveness in the market."

# EUROPEAN UNION SEMICONDUCTOR SECTOR POLICY INSTRUMENTS

The EU currently has several policy and support initiatives in the field of semiconductors.

- The European Chips Act
- The Important Project of Common European Interest (IPCEI) on microelectronics[34]
- The Recovery and Resilience Fund
- RDI programmes such as:
  - The Joint Undertakings[35]
  - Horizon Europe[36]
- The European Innovation Council[37] and
- The Digital Europe Programme[38]

34 https://www.ipcei-me.eu

35 https://digital-strategy.ec.europa.eu/en/news/commission-welcomes-approval-10-european-partnerships-accelerate-green-and-digital-transition

36 https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

37 https://eic.ec.europa.eu/index_en

38 https://digital-strategy.ec.europa.eu/en/activities/digital-programme

# EUROPEAN CHIPS ACT


The key EU level Policy Instrument to strengthen the EU Semiconductor Sector is "The European Chips Act". This Act, which reached a political agreement between the European Parliament and the Council on 18 April 2023[39], is composed of a Communication, which spells out the European Strategy and rationale behind the Chips Act, a proposal for a Regulation, and a Recommendation to Member States to monitor the semiconductor supply chain.

The European Chips Act[40] seeks to reinforce the semiconductor ecosystem in the EU, to ensure the resilience of supply chains and reduce external dependencies. It is a key step for the EU's technological sovereignty. It seeks to ensure Europe meets its digital decade target of doubling its global market share in semiconductors to 20%.

The Chips Act focuses on 5 strategic objectives:

1. strengthening research and technological leadership;
2. building and reinforcing Europe's capacity to innovate in the design, manufacturing and packaging of advanced chips;
3. putting in place an adequate framework to increase production by 2030;
4. addressing the skills shortage and attracting new talent; and
5. developing an in-depth understanding of global semiconductor supply chains.

The European Chips Act has 3 main components:

1. a "Chips for Europe" Initiative to support large-scale technological capacity building and innovation in cutting-edge chips;
2. a new framework to attract large-scale investments in production capacities and ensure the security of supply; and
3. a coordination mechanism between the Member States and the Commission to monitor market developments and anticipate crises.

39 https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2045

40 https://digital-strategy.ec.europa.eu/en/library/european-chips-act-factsheet

## CHIPS FOR EUROPE INITIATIVE

The Chips for Europe Initiative will reinforce semiconductor technologies and innovation capabilities, ensuring EU leadership in this field in the mid to long term. It will mainly be implemented through the Chips Joint Undertaking — previously known as the Key Digital Technologies Joint Undertaking.

The Chips for Europe Initiative will:

- reinforce Europe's leadership in research;
- enable access across Europe to chips design tools, and pilot lines for prototyping and testing innovative chips technologies;
- establish a certification procedure for energy-efficient and trusted chips to guarantee their quality and security for critical applications;
- foster education, skills and talent in microelectronics; and
- support a network of competence centres across Europe for promoting innovative design and use of semiconductors systems.

## A NEW FRAMEWORK TO ENSURE SECURITY OF SUPPLY

The Chips Act proposes a new framework to ensure the security of supply of chips by attracting investments and supporting the establishment of large-scale production capacities.

The framework allows for public support for two new types of innovative production facilities that are the first of their kind. These new facilities are:

- 'Open EU Foundries', which would dedicate a significant amount of their manufacturing capacity to production for other industrial players; and
- 'Integrated Production Facilities', which would design and produce chips for their own markets (for example for just their sector).

## COORDINATION MECHANISM BETWEEN THE MEMBER STATES AND THE COMMISSION TO MONITOR MARKET DEVELOPMENTS AND ANTICIPATE CRISES.

In view of the ongoing chips shortage crisis, the Commission also put forward a Recommendation to Member States encouraging immediate coordination actions between the Member States and the Commission to address the crisis. The Recommendation sets out mechanisms for monitoring and mitigating disruptions in the supply chains and making Europe more resilient in the face of current and future disruptions.

On the 10 May 2023, the Commission launched the Semiconductor Alert System[41] a new pilot system, to monitor the semiconductor supply chain.

41 https://ec.europa.eu/eusurvey/runner/Semiconductor_Alert_System

The alert system allows EU stakeholders to raise awareness on any critical disruption along the semiconductors' value chain and helps the Commission to monitor the supply of semiconductors, anticipate shortages, and, if necessary, trigger the activation of a crisis stage, via the European Semiconductor Expert Group (ESEG)[42].

This Semiconductor Alert System will be included under the third pillar of the European Chips Act, with the ESEG replaced by the European Semiconductor Board, composed of representatives from the Member States and chaired by the Commission.

# IMPORTANT PROJECT OF COMMON EUROPEAN INTEREST (IPCEI)

The "Important Project of Common European Interest "(IPCEI)[43] is a key strategic instrument with regard to the implementation of the European Union Industrial Strategy and EU Semiconductor manufacturing ambitions. An IPCEI brings together knowledge, expertise, financial resources and economic actors throughout the Union, to overcome important market or systemic failures which could not otherwise be addressed. IPCEI are large-scale European consortia in key strategic value chains featuring tightly connected company projects. IPCEI features projects with a dedicated focus on First Industrial Deployment (FID)as well as Research and Development.

An IPCEI requires the approval of the European Commission under state aid law. Companies and Member States in a dedicated notification process must prove that the IPCEI follows an overriding European interest and that projects would not be realised under market forces alone. With their approval, the European Commission ensures that all EU Member States can benefit, that there is no disproportionate distortion of competition and that companies within their projects adhere to the IPCEI criteria as laid down in the IPCEI communication.

**Example of an IPCEI in the semiconductor sector**

The most recent example of an IPCEI in the field of Semiconductors is the Important Project of Common European Interest (IPCEI) on Microelectronics and Communication Technologies[44], approved by the European Commission on June 8, 2023. This IPCEI with €8.1 billion of state aid, will trigger €13.7 billion of additional private investment and therefore a total investment of around €22 billion in the European semiconductor supply chain.

The supported manufacturing projects will sow the seeds for future major production facilities in Europe which could find support as first-of-a-kind endeavours under the EU Chips Act framework that allows for public support for innovative first of their kind major production facilities including Open EU Foundries and Integrated Production Facilities.

42 https://ec.europa.eu/transparency/expert-groups-register/screen/expert groups/consult?lang=en&groupID=3838

43 Communication from the Commission - Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52014XC0620%2801%29

44 Commission approves up to €8.1 billion of public support by fourteen Member States for an Important Project of Common European Interest in microelectronics and communication technologies; https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3087

Important Project of Common European Interest (IPCEI) on Microelectronics and Communication Technologies

Approved 08-06-2023

This latest IPCEI is yet **another demonstration of the EU Chips Act already triggering considerable public and private investment** across the European semiconductor value chain: from **materials to design, from equipment to advanced packaging**.

This IPCEI is considerable in its size and pan-European dimension: **68 projects from 56 companies from 19 Member States** (plus Norway), involving 600 indirect partners and **potentially creating more than 8700 direct jobs in Europe** – and many more indirectly.

This IPCEI will **expand industrial presence across the supply chain in Europe**, investing in major, innovative industrial capacities on all the chokepoints of the supply chain: **materials** including wafers; **equipment** (for wafer production, chip production, packaging assembly and test); **design** and design automation tools, different **process** technologies, **manufacturing**, **packaging**, **assembly**, and tests; and **systems integration**.

Under the IPCEI, companies – **including many SMEs** – will develop innovative device technology including dedicated processors, AI chips, programmable integrated circuits (FPGAs), embedded memory, chiplets, optical interconnects as well as equipment and materials, in support of the development of innovative applications for the communications, automotive, industrial automation and consumer IoT sectors as well as AI, edge-computing and other markets.

The IPCEI will:

- **Accelerate the development of a European supply chain for components needed for communications equipment** as well as radar and space applications. Developing cybersecure connectivity capabilities and preparation of 5G/6G standards will form part of these efforts.
- **Prepare Europe for the roll-out of electric vehicles**, notably to enable design and manufacturing capacity for next-generation devices and substrates for power management as well as the environmental sensors, radars and in-vehicle computers needed for highly automated driving functions.
- **Develop the next-generation AI chips**, combining strengths in both analog and digital, low-power computing and new generations of optical sensors will open the door to new markets in edge-AI, industrial automation and beyond.

# THE RECOVERY AND RESILIENCE FUND

The Recovery and Resilience Facility (RRF) is a temporary instrument that is the centrepiece of NextGenerationEU[45], the EU's €800 billion temporary recovery instrument to support the economic recovery from the coronavirus pandemic and build a greener, more digital and more resilient future.


45 NextGenerationEU, https://commission.europa.eu/strategy-and-policy/eu-budget/eu-borrower-investor-relations/nextgenerationeu_en

The RRF instrument offers grants and loans to support reforms and investments in the EU Member States for a total of €723.8 billion in current prices.

Part of the funds – up to €338 billion – are provided to Member States in the form of grants.

Another part – up to €385.8 billion – funds loans to individual Member States. These loans will be repaid by those Member States

One example of the use of National RRF funds is the construction of a manufacturing plant in the semiconductor value chain in Catania, Sicily[46] under EU State rules.

The project, notified by Italy, is funded by the RRF, following the Commission's positive assessment of Italy's RRF[47] and its adoption by the Council.

Italian support of €292.5 million plant in the semiconductor value chain in Catania, Sicily.

The EC approved aid will take the form of a €292.5 million direct grant to support STMicroelectronics' €730 million investment for the construction of a Silicon Carbide ('SiC') wafer plant in Catania. SiC is a compound material used to manufacture wafers that serve as a base for specific microchips used in high-performance power devices, such as in electric vehicles, fast-charging stations, renewable energies, and other industrial applications.

The project, which is planned to be completed in 2026, will be the first industrial scale, integrated epitaxy SiC wafers production line in Europe. It will integrate in the same production facility the whole SiC substrate value chain, namely from the production of the raw material ('SiC powder') to the manufacturing of the SiC wafers. The SiC wafers will be ready for further use as a result of an additional treatment process at the facility, in which a specific epitaxial layer is applied to the SiC wafers, enhancing their technical capabilities (so-called 'SiC epiwafers').

# EU RDI PROGRAMMES

Several of the EU programmes such as The Joint Undertakings48, Horizon Europe49 and The Digital Europe Programme50 have support initiatives in the field of semiconductors.

46 https://ec.europa.eu/commission/presscorner/detail/en/IP_22_5970

47 https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/italys-recovery-and-resilience-plan_en

48 https://digital-strategy.ec.europa.eu/en/news/commission-welcomes-approval-10-european-partnerships-accelerate-green-and-digital-transition

49 https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

50 https://digital-strategy.ec.europa.eu/en/activities/digital-programme

## JOINT UNDERTAKINGS (JU):

The flagship Joint Undertaking in the semiconductor sector is the Key Digital Technologies[51] (KDT) JU[52] with an EU budget contribution of € 1.8 billion.

**Note:** The European Chips Act gives a legal framework for a new public-private partnership – the "Chips Joint Undertaking" - building on the existing KDT JU and with an even more ambitious scope and a much more significant budget: the EU contribution is proposed to be increased from € 1.8 billion up to € 4.175 billion.

The Key Digital Technologies Joint Undertaking - the Public-Private Partnership for research, development and innovation – funds projects for assuring world-class expertise in these key enabling technologies, essential for Europe's competitive leadership in the era of the digital economy. KDT JU is the successor to the ECSEL JU programme, supporting its ongoing projects.

Within the KDT JU, EU industry is supported and co-financed by the KDT JU Participating States and the European Union.

### KDT JU OBJECTIVES:

- Reinforce the EU's strategic autonomy in electronic components and systems;
- Establish EU scientific excellence and innovation leadership in emerging components and systems technologies;
- Ensure that components and systems technologies address Europe's societal and environmental challenges;
- Support research and development for establishing design and production capabilities in Europe for strategic application areas;
- Launch a balanced portfolio of large and small projects supporting the fast transfer of technologies from the research to the industrial environment;
- Foster a dynamic EU-wide ecosystem based on digital value-chains with simplified access to newcomers;
- Support research and development for enhancing component technologies that guarantee security, trust and energy-efficiency for critical infrastructures and sectors in Europe;
- Foster mobilisation of national resources and ensure coordination of Union and national research and innovation programmes in the field of electronic components and systems;
- Establish coherence between the Strategic Research and Innovation Agenda of the Key Digital Technologies Joint Undertaking and Union policies so that electronics components and systems technologies contribute efficiently.

51 https://www.kdt-ju.europa.eu

52 KDT JU was established through a COUNCIL REGULATION (Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe).

### KDT JU MEMBERS

- European industry, SMEs and Research and Technology Organisations (RTOs) are represented by three industry associations[53] representing the actors from the areas of micro- and nano-electronics, smart integrated systems and embedded/cyber-physical systems.
  - AENEAS is an Industry Association promoting RD&I in Electronic Components & Systems to strengthen European competitiveness.
  - INSIDE Industry Association is the association for actors in Embedded Intelligent Systems within Europe and,
  - EPoSS e.V., the European Technology Platform on Smart Systems Integration, is an industry-driven policy initiative, defining R&D and innovation needs and requirements related to Smart Systems Integration and integrated Micro- and Nano systems.
- the European Union (through the Commission);
- Member States and Associated Countries to the Horizon Europe Programme on a voluntary basis (the "Participating States").

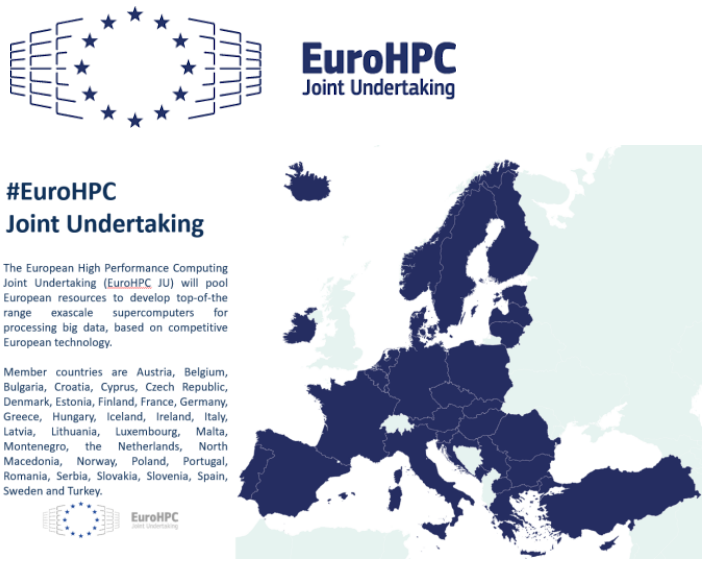
### KDT JU PARTICIPATING STATES:

Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Hungary, Ireland, Israel, Iceland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, Turkey.

# EUROPEAN HIGH PERFORMANCE COMPUTING JOINT UNDERTAKING (EUROHPC JU)

The EuroHPC JU is a legal and funding entity, created in 2018 and recently reviewed by means of Council Regulation (EU) 2021/1173, to lead the way in European supercomputing.

The EuroHPC JU, located in Luxembourg, allows the European Union and the EuroHPC JU participating countries to coordinate their efforts and pool their resources to make Europe a world leader in supercomputing. This boosts Europe's scientific excellence and industrial strength,




53 https://www.kdt-ju.europa.eu/industry-associations-kdt-ju

## MISSION

The EuroHPC JU aims to:

- develop, deploy, extend and maintain in the EU a world-leading federated, secure and hyper-connected supercomputing, quantum computing, service and data infrastructure ecosystem;
- support the development and uptake of demand-oriented and user-driven innovative and competitive supercomputing system based on a supply chain that will ensure components, technologies and knowledge limiting the risk of disruptions and the development of a wide range of applications optimised for these systems;
- widen the use of that supercomputing infrastructure to a large number of public and private users and support the development of key HPC skills for European science and industry.


## BUDGET

The EuroHPC Joint Undertaking is jointly funded by its members with a budget of around EUR 7 billion for the period 2021-2027.

Most of this funding comes from the current EU long-term budget, the Multiannual Financial Framework (MFF 2021-2027) with a contribution of EUR 3 billion, distributed as follows:

- EUR 1,9 billion from the Digital European Programme (DEP) to support the acquisition, deployment, upgrading and operation of the infrastructures, the federation of supercomputing services, and the widening of HPC usage and skills;
- EUR 900 million from Horizon Europe (H-E) to support research and innovation activities for developing a world-class, competitive and innovative supercomputing ecosystem across Europe;
- EUR 200 million from the Connecting Europe Facility-2 (CEF-2) to improve the interconnection of HPC, quantum computing, and data resources, as well as the interconnection with the Union's common European data spaces and secure cloud infrastructures.

The EU contribution is matched by a similar amount from the participating countries. Additionally, private members are contributing an amount of EUR 900 million.

The Joint Undertaking provides financial support in the form of procurement or research and innovation grants to participants following open and competitive calls.

### SEMICONDUCTOR TECHNOLOGIES FOR HPC

The EuroHPC supports EU initiatives towards strategic autonomy in HPC chip technologies. Key results include:

- Cutting- edge technologies e.g., Rhea General- Purpose Processor (GPP) & a proof-of- concept implementation of European accelerator technology.
- 1st gen of low-power processor units,
- 2nd gen of low-power accelerator test chips,

## HORIZON EUROPE

Horizon Europe (HE) is the EU's key funding programme for research and innovation with a budget of EUR 95.5 billion for the period from 2021-2027. This includes EUR 5.4 billion from the Next Generation EU instrument, particularly to support the green and digital recovery from the COVID crisis.


Key digital technologies including quantum technologies along with manufacturing technologies are supported under Cluster 4: Digital, Industry and Space of the HE programme which has a Total budget of €15.35 billion.

### CLUSTER 4: DIGITAL, INDUSTRY AND SPACE

The overarching vision behind the investments under Cluster 4 is that of Europe shaping competitive and trusted technologies for a European industry with global leadership in key areas, enabling production and consumption to respect the boundaries of our planet, and maximising the benefits for all parts of society in the variety of social, economic and territorial contexts in Europe.

### THE KEY FOCUS AREAS ARE:

- manufacturing technologies
- key digital technologies including quantum technologies
- emerging enabling technologies
- advanced materials

- artificial intelligence and robotics
- next generation internet
- advanced computing and Big Data
- circular industries
- low carbon and clean industries
- space including earth observation

Specific relevant aspects of the Horizon Europe - Work Programme 2023-2024 Digital, Industry and Space include:

- Sovereignty in digital technologies and in future emerging enabling technologies by strengthening European capacities in key parts of digital and future supply chains, allowing agile responses to urgent needs, and by investing in early discovery and industrial uptake of new technologies.
- Globally attractive, secure, and dynamic data-agile economy by developing and enabling the uptake of the next-generation computing and data technologies and infrastructures (including space infrastructure and data), enabling the European single market for data with the corresponding data spaces and a trustworthy artificial intelligence ecosystem.
- Open strategic autonomy in conceiving, developing, deploying, and using global space- based infrastructures, services, applications and data, including by reinforcing the EU's independent capacity to access space, securing the autonomy of supply for critical technologies and equipment, and fostering the EU's space sector's competitiveness.

# EUROPEAN INNOVATION COUNCIL

The European Innovation Council (EIC) has been established under the EU Horizon Europe programme. It has a budget of €10.1 billion to support game changing innovations throughout the lifecycle from early-stage research to proof of concept, technology transfer, and the financing and scale up of start-ups and SMEs.

European Innovation Council

The European Innovation Council (EIC) 2023 work programme[54] opens funding opportunities worth €1.6 billion in 2023 for scientists and innovators to scale up breakthrough technologies and create new markets. Of particular interest in this semiconductor report, is the half a billion euro earmarked for next generation technologies in strategic areas for Europe, including energy storage, quantum and semi-conductors.

54 https://eic.ec.europa.eu/eic-2023-work-programme_en

# DIGITAL EUROPE PROGRAMME

The Digital Europe Programme provides funding for projects in five crucial areas:

- supercomputing
- artificial intelligence
- cybersecurity
- advanced digital skills
- ensuring the wide use of digital technologies across the economy and society

The overall budget of €7.5 billion[55] (in current prices), complements the funding available through other EU programmes (described above), such as the Horizon Europe programme for research and innovation and the Recovery and Resilience Facility, to name a few. It is a part of the long-term EU budget, the Multiannual Financial Framework 2021-2027.


## THE DIGITAL EUROPE PROGRAMME BUDGET INCLUDES:

- €2.2 BILLION for supercomputing to build up and strengthen the EU's
- €1.6 BILLION for cybersecurity to strengthen cybersecurity coordination between Member States tools and data infrastructures.

55 https://digital-strategy.ec.europa.eu/en/activities/digital-programme

# 5 CONCLUSIONS AND RECOMMENDED POLICY ACTIONS

This study presents a brief review of the global semiconductor manufacturing landscape along with a mapping of the key Brazilian and EU actors in the different segments of their respective semiconductor supply chains.

A concise review of Brazilian and EU level policies, initiatives, and instruments for supporting and strengthening their semiconductor industry ecosystems, and for minimising future perturbations in their supply chains, is also provided.

The review of the respective semiconductor supply chains has identified the following key findings:

- The world-leading strengths of the Brazilian and EU semiconductor supply chains in the automotive and communications sectors and their value chains.
- The strong presence of leading EU automotive and communications sector OEM's and Tier 1 players in the Brazilian ecosystems and supply chains. Examples include Valeo, Nokia and Ericsson who all have manufacturing facilities, and for all three, their unique Latin American R&D centre in Brazil.
- The Brazilian and EU semiconductor supply chains have specific strengths and vulnerabilities in different segments of their supply chains.
    - In the case of Brazil, a weakness in the semiconductor manufacturing segment of the supply chain; while in the case of the EU, a lack of capacity and capability in the assembly, test, and packaging segment (now being rapidly built-out).
    - In contrast, Brazil has strengths in the ATP segment of the semiconductor supply chain and offers, outside of East Asia, the largest concentration of Outsourced semiconductor assembly and test (OSAT) services. While the EU has world leadership in the equipment segment of the semiconductor supply chain and comprehensive, world-leading semiconductor supply chains for the automotive sector.
- Both the Brazilian and EU semiconductor ecosystems have strong research ecosystems with differing capabilities across the semiconductor segments.

- Both Brazil and the EU have identified semiconductor design as a strategic enabler to build competitive advantage in the semiconductor value chain.
- Both Brazil and the EU have strong policies and targeted support schemes for the semiconductor supply chain ecosystem in general, and in particular, for the semiconductor supply chains for the automotive and communications sectors.
    - In Brazil, these policies include the PADIS (Support Program for the Technological Development of the Semiconductor Industry), the ICT Law (Informatics and Communication Law) for companies in the information and communication technologies (ICT) sector, the Rota 2030 (Route 2030) Law 13.755/18 for support of companies in the automotive sector and the Lei do Bem (Good Will) - Law 11.196/05 which supports all companies across all sectors performing technological innovation.
    - In the EU, support policies and instruments include: the European Chips Act, the Important Project of Common European Interest (IPCEI), elements of the Recovery and Resilience Fund, RDI support programmes such as The Joint Undertakings, Horizon Europe and The European Innovation Council.
- Both Brazil and the EU have experienced significant semiconductor supply chain disruptions with consequent impact on strategic industrial sectors and manufacturing output.

Based on the semiconductor supply chain mapping, related semiconductor policy analysis, and discussions with different stakeholders, several policy recommendations have been identified, in three thrust areas:

- Increasing industry collaboration (Recommendations 1-3),
- enhancing inter-regional semiconductor ecosystems across all areas, education, training and best-practices (Recommendations 4-6), and finally,
- a cross-cutting initiative to coordinate actions and share intelligence to improve the resilience of Brazilian and EU semiconductor supply chains (Recommendation 7).

## THESE RECOMMENDATIONS ARE PRESENTED BELOW:

- **RECOMMENDATION 1: Increase Brazilian and EU industry collaboration in strategic semiconductor research and development (R&D) programmes**, including, where possible, through making full use of future R&D opportunities under the Chips Joint Undertaking and other appropriate industry focused RDI partnerships.
- **RECOMMENDATION 2: Strengthen the industrial partnerships and value chain linkages between Brazil and the EU in the semiconductor supply chain for automotive and communications**, to help integrate our value chains and boost the competitiveness of our industries globally. Leverage, where possible, the existing EU corporate linkages in Brazil (including EU subsidiary's corporate research centres in Brazil). Facilitate participation of EU corporate research centres in Brazil in European innovation programmes.
- **RECOMMENDATION 3: Promote a Brazil – EU SME platform and actions to accelerate the growth of high-tech SMEs and start-ups**, through linkages and cooperation between SME players in the semiconductor supply chain. This action could leverage existing EU platforms such as the European Enterprise

Network (with dedicated sustainability advisors), the European Digital Innovation Hubs in the semiconductor sector, and the EU Start-up Nations initiative.

- **RECOMMENDATION 4: Create interregional Brazilian – EU semiconductor partnerships to boost trade, supply chain competitiveness and innovation.** Brazilian and EU regions through their semiconductor clusters would be encouraged to take part in this initiative and to develop a pipeline of semiconductor investment projects. This action could leverage the EU Smart Specialisation Platform[56].
- **RECOMMENDATION 5: Enhance semiconductor ecosystem cooperation and communication through a joint EU-Brazil Semiconductor Competence Centre.** This joint competence centre would connect Brazilian actors to the emerging network of EU member state semiconductor competence centres and likewise, connect EU actors to the rich network of Brazilian state centres and APCI program centres.
- **RECOMMENDATION 6: Promotion bilateral initiatives on postgraduate education and training of semiconductor engineers, technologists, scientists, and entrepreneurs**. For example, an opportunity might be the participation of Brazil in an EU Erasmus Mundus Joint Masters study programme on semiconductors[57]. From a Brazilian perspective, consider an adaptation of the former Brazilian "Science w.o. borders" programme repurposed to an EU-Brazil Semiconductors w.o. borders programme).
- **RECOMMENDATION 7: Coordinate actions and share intelligence to improve the resilience of Brazilian and EU semiconductor supply chains,** including monitoring the functioning of the Brazilian and EU semiconductor supply chains, as well as detection and response to crises through coordinated correcting measures. This action could leverage and reinforce the EU Semiconductor Alert System[58] now in place since May 2023 to monitor the EU semiconductor supply chain.

56 https://single-market-economy.ec.europa.eu/industry/strategy/interregional-partnerships_en

57 Erasmus Mundus Joint Masters study programmes combine at least two EU Member States and third countries associated to the Programme. While Brazil is not associated to the programme, it is eligible to take part in certain Actions of the Programme.

58 https://ec.europa.eu/eusurvey/runner/Semiconductor_Alert_System

# 6 ANNEX A:

## BRAZILIAN R&D CENTRES IN THE FIELD OF SEMICONDUCTORS

### CBPF /LABNANO

CBPF – Centro Brasileiro de Pesquisas Físicas is a national center belonging to MCTI, which hosts a nanofabrication facility called LABNano. Clean room area class 1000 with some equipment under class 100 flows.

### CTI RENATO ARCHER

CTI is a state research centre belonging to MCTI. It was founded in 1982 and is located in Campinas, SP.

Main activities:

- R&D on Micro-nanodevices, sensors and photonics
- Advanced solar cell technologies: Hybrid tandem double junction Perovskita on Silicon; quantum dot semiconductor and doped plasmonic nanoparticles
- Flexible, textile and wearable electronics based on nanomaterials (graphene, metallic carbon nanotubes, MXens)
- LED's and Nanoscintilators
- Microfabrication services: mask making, lithography, pattern generation, different type of microscopy and analysis.
- Applications:
- Industry 4.0
- Advanced medicine

## IBTI – INSTITUTO BRASÍLIA DE TECNOLOGIA E INOVAÇÃO

IBTI is a private non-profit R&D centre located in Brasília, DF. Their TIC activities include hardware and software. They are starting the development of an X-ray diagnosis tool (a portable tomograph), using an X-ray detector developed by Lumentum. Their portfolio does not include specific areas of microelectronics, except applications, system design, IoT, and others.

## INSTITUTO DE INOVAÇÃO SENAI EM MICROELETRÔNICA – ISI MICROELETRÔNICA

SENAI[59] is an organization supported by Brazilian Industry to foster training and services for the industry. They have a branch for Innovation, starting 25 new Institutes in different regions and on different specializations. One on Microelectronics was created in Manaus, AM.

**Main activities:**

- Reliability of components
- Prototyping of products
- Electronics testing
- Fabrication processes for semiconductors

## INSTITUTO ELDORADO

Eldorado is a private non-profit R&D centre located in Campinas, with a focus on TIC and Microelectronics. Its activities in the area of Microelectronics include:

- ASIC Design: Digital and Analog
- Advanced Packaging of IC's
- Package Design – SiP

**Key technical results include:**

- DTV-ISDBt Digital TV demodulator chip (65 nanometers),
- EPC Global-915MHz RFID chip (180 nanometers),
- Pacemaker chip (180 nanometers),
- 24-bit ADC chip (180 nanometers),
- DSP chip for high-speed communication in 28, 14 and 7 (nanometers)
- IEEE 802.15 Chip Transceiver. 4.G 65 (nanometers).

59 http://www.fieam.org.br/senai/instituto-senai-de-inovacao-microeletronica-isi/ .

- MCM (Multi Chip Module) modules to integrate solutions in Digital TV and Pacemaker,
- SiP (System in Package) of memory modules and high-speed photonic modules.

## INSTITUTO TECNOLÓGICO DE SEMICONDUTORES – ITT CHIP

ITT Chip is a private institute inside the university UNISINOS in São Leopoldo, RS. They are located very close to the site of Hana Micron (packaging company) and have a strong collaboration with that company.

**Main Activities:**

- Sensors and Semiconductor Packaging and Test development
- Multicomponent packaging development (SiP – System in Package)
- Design, simulation, qualification, failure analysis and prototyping services
- Sensors for health applications (microfluidic and wearable sensors).
- acts as an entrepreneurship hub that can house start-up companies.

**Main results include:**

- Integrated Solutions (SiPs) for IoT application (Sigfox, LoRA and NB/5G) like iMCP HT32SX in partnership with HT Micron Semiconductors S.A
- Sensors for health applications like Intracranial Pressure Sensor in partnership with Toth Lifecare
- Blood coagulation sensors in partnership with Biosensor

## LABORATÓRIO NACIONAL DE NANOTECNOLOGIA – LNNANO

ILNNano is a national lab belonging to MCTI within CNPEM (Centro Nacional de Pesquisa em Energia e Materiais), located in Campinas. It has a sister lab called LNLS (Laboratório Nacional de Luz Sincrotron) on the same campus.

**Main Activities**

- synthesis, device fabrication and optoelectronic characterization of organic semiconductors, 2D semiconductors, semiconductor quantum dots, metal-oxide semiconductors, III-V semiconductors grown by Molecular Beam Epitaxy (MBE),
- theory and modelling of semiconductor materials.
- development of devices for flexible and wearable electronics, thin-film transistors made of 2D semiconductors and van der Waals heterostructures, fundamental studies on the electronic structure and charge transport within semiconducting structures, neuromorphic and bioelectronic devices, micro and nanofabrication of devices for quantum technologies, etc.
- applications of ASICS for hybrid technologies of X-Ray detection,

- fabrication of semiconducting sensors for hybrid X-Ray detectors
- fabrication and optoelectronic characterization of 2D semiconductors.
- the IMBUIA beamline is a multi-user facility at LNLS that uses synchrotron infrared (IR) radiation generated by the new Brazilian particle accelerator,
- Sirius, is dedicated to nanophotonics, optoelectronics and basic characterization of new dielectric and insulating materials.

**Main Results**

In the three years (2020-2022) they have published 84 peer reviewed scientific papers, filed 3 patents and fabricated 20 detectors of various types.

- Expansion and investment plans for short/medium term:
- Ongoing acquisition of equipment for device fabrication and metrology (~1M US$ - FINEP BIO2NANO).
- Prospecting the expansion of the current fabrication capabilities to 1400 m2 cleanroom space with novel and improved equipment (~ 60M U$).
- A new beamline of far-IR and THz nanospectroscopy dedicated to the study of fundamental physical phenomena in quantum, semiconductor, photonic and optoelectronic materials. The predicted investment in this new facility is ~10 MBRL over the next 2-3 years.

## ONINN

Oninn is a private institution located in Belo Horizonte. It started in 2006 under the name CSEM Brasil, by FIR capital and CSEM SA (Centre Suisse d' Electronique et de Microtechnique) and support of the Minas Gerais State Government, to act as a bridge between science and industry, transforming technology in products.

**Main Activities/Projects**

- Sensors for failure detection, diagnosis, and prognosis of wind-mil energy generators
- Energy Trade - Energy management software for vertical greenhouses cultivation, controlling multiple parameters and illumination – for AES.
- EVUST - Remote monitoring systems for utility providers – for ENERGISA
- Development of Perovskita solar cell modules, that can be printed by Blade Coating and role to role processes – for Petrobras.
- OPV – An adhesive process of OPV films on glass facades.
- Wireless Sensor Networks – Application on smart mineral transport belts – for Bosch
- Organic Photodetectors – With high performance, low cost for diagnosis with X-rays – for Philips

## CENTRO DE PESQUISAS AVANÇADAS WERNHER VON BRAUN

Von Braun Labs is a private non-profit R&D center located in Campinas, with focus on a broad spectrum of TIC and Microelectronics.

### Main Activity Areas

- Semiconductor Design and associated Manufacturing Technologies
- Structuring Fabless Semiconductor Operations
- Structuring of Cloud Services and AI functions
- Industrial Automation, Manufacturing 4.0/5.0
- Development of IoT Technological Solutions
- Embedded Systems and Integration
- Applied Physics

### Main results

Some examples of Technological Solutions (specific to the use of chips and associated cloud services for payments, traceability, and control) that can be mentioned and are not under confidentiality with the customers:

- https://www.semparar.com.br/sem-parar-pay
- https://www.semparar.com.br/
- https://www.facebook.com/djr.consultoria/videos/psmm-prima-solli-magneti-marelli-goiana-pe-jeep/531876447223119/
- https://www-defesaaereanaval-com-br.cdn.ampproject.org/c/s/www.defesaaereanaval.com.br/defesa/avibras-e-classificada-para-receber-recursos-da-finep/amp
- http://hsxdata.com.br/

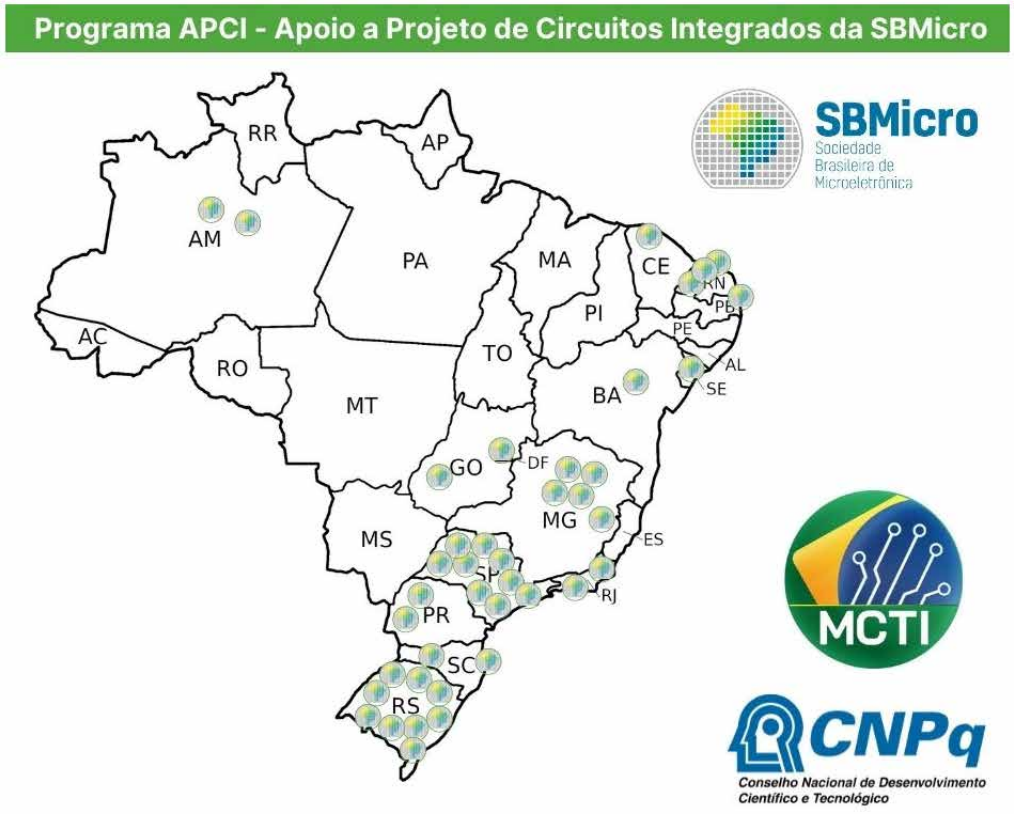
# 7 ANNEX B:

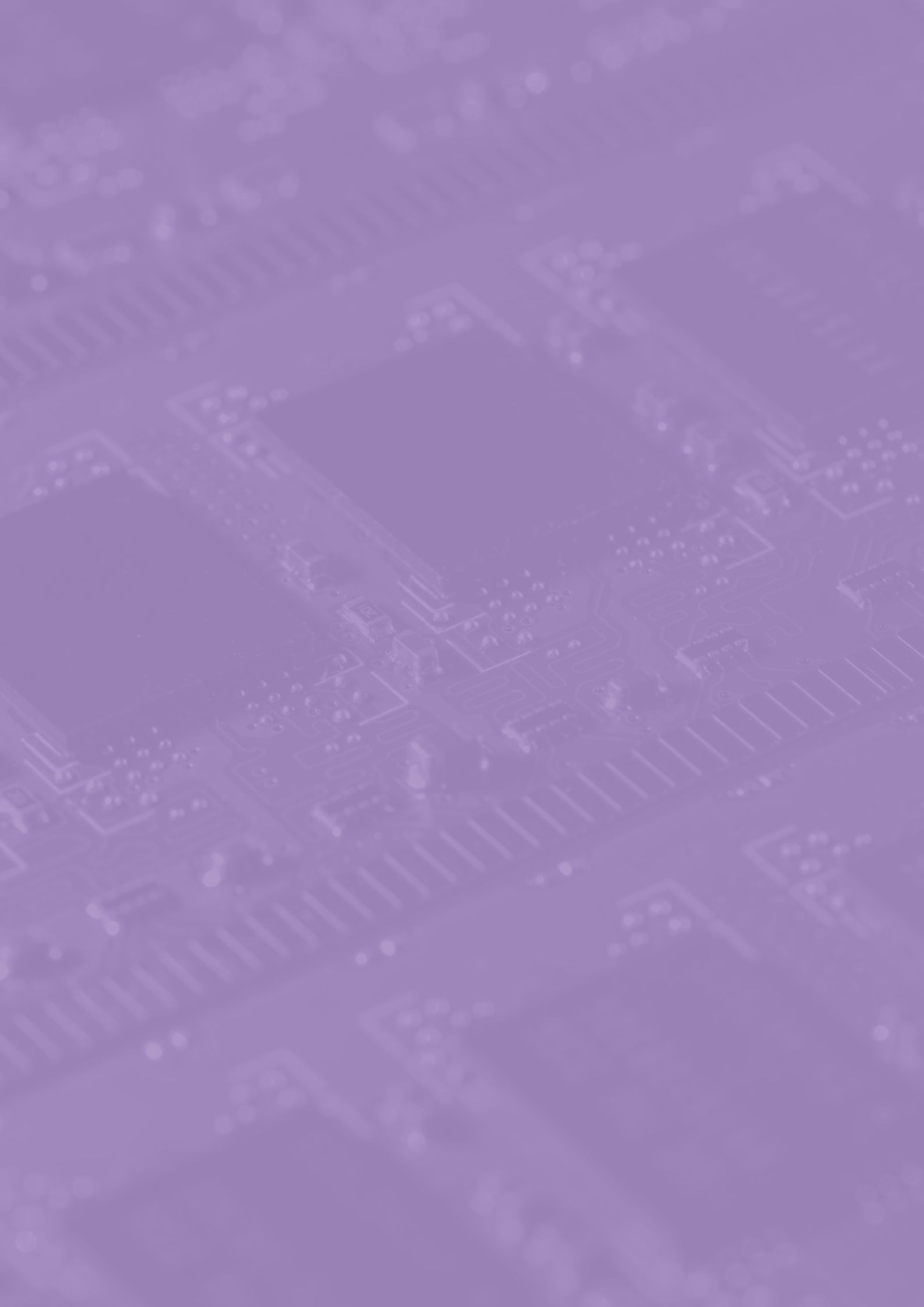
## UNIVERSITIES INVOLVED IN IC DESIGN AND EDA TOOL DEVELOPMENT

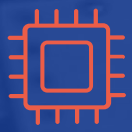
| University | # Profs | # PhD Students | # MSc Students |
|---|---|---|---|
| CEFET-MG - Centro Federal de Educação Tecnológica de Minas Gerais | 8 | 0 | 3 |
| CEFET-RJ - Federal Center for Technological Education Celso Suckow da Fonseca | 2 | 1 | 0 |
| FEI - Centro Universitário da FEI | 2 | 3 | |
| FURG - Universidade Federal do Rio Grande | 3 | 1 | 1 |
| IFSP - Instituto Federal de São Paulo | 5 | 0 | 0 |
| ITA - Instituto Tecnológico de Aeronáutica | 10 | 0 | 5 |
| PUCRS - Pontifícia Universidade Católica do Rio Grande Do Sul | 8 | 15 | 9 |
| UCPEL - Universidade Católica de Pelotas | 3 | 0 | 6 |
| UEA-Universidade do Estado do Amazonas | 1 | 0 | 0 |
| UERGS - State University of Rio Grande do Sul | 5 | 0 | 0 |
| UFABC - Federal University of ABC | 6 | 0 | 2 |
| UFAM - Universidade Federal de Manaus | 4 | 4 | 0 |
| UFBA - Universidade Federal da Bahia | 5 | 13 | 8 |
| UFC - Universidade Federal do Ceará | 3 | 5 | 3 |
| UFERSA - Universidade Federal Rural do Semi-Árido - Mossoró | 1 | 0 | 4 |
| UFERSA - Universidade Federal Rural do Semi-Árido - Pau dos Ferros | 5 | 1 | 3 |
| UFG - Federal University of Goiás | 8 | 1 | 0 |
| UFMG - Universidade Federal de Minas Gerais | 6 | 3 | 9 |
| UFPB - Universidade Federal da Paraíba | 1 | 1 | 2 |
| UFPEL - Universidade Federal de Pelotas | 13 | 13 | 2 |
| UFPR - Universidade Federal do Paraná | 7 | 2 | 5 |
| UFRGS - Universidade Federal do Rio Grande do Sul | 17 | 32 | 45 |
| UFRJ - Federal University of Rio de Janeiro | 6 | 2 | 4 |
| UFRN - Federal University of Rio Grande do Norte | 4 | 3 | 2 |
| UFS - Universidade Federal do Sergipe | 3 | 0 | 1 |
| UFSC - Universidade Federal deSanta Catarina | 11 | 12 | 11 |
| UFSM - Universidade Federal de Santa Maria | 8 | 0 | 5 |
| UFV - Universidade Federal de Viçosa | 2 | 3 | 3 |

| University | # Profs | # PhD Students | # MSc Students |
|---|---|---|---|
| UNB - Universidade Federal de Brasília | 9 | 3 | 9 |
| UNESP - Universidade Estadual Paulista | 4 | 0 | 1 |
| UNICAMP - Universidade Estadual de Campinas | 8 | 16 | 21 |
| UNIFEI - Universidade Federal de Itajubá | 7 | 2 | 3 |
| UNIFEI – Itabira | 3 | 0 | 3 |
| UNIPAMPA - Universidade Federal do Pampa | 4 | 0 | 2 |
| UNISANTOS - Universidade Católica de Santos | 1 | 0 | 0 |
| UNISINOS - Universidade do Vale do Rio dos Sinos | 3 | 0 | 3 |
| UNIVALI - Universidade do Vale do Itajaí | 3 | 0 | 3 |
| USP - Universidade de São Paulo | 8 | 1 | 12 |
| USP-EESC Escola de Engenharia de São Carlos | 3 | 1 | 2 |
| UTFPR - Universidade Tecnológica Federal do Paraná | 1 | 0 | 0 |
| **Total** | **211** | **138** | **192** |

The location and distribution of the university members of the APCI program across Brazil is shown opposite.







MINISTRY OF
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