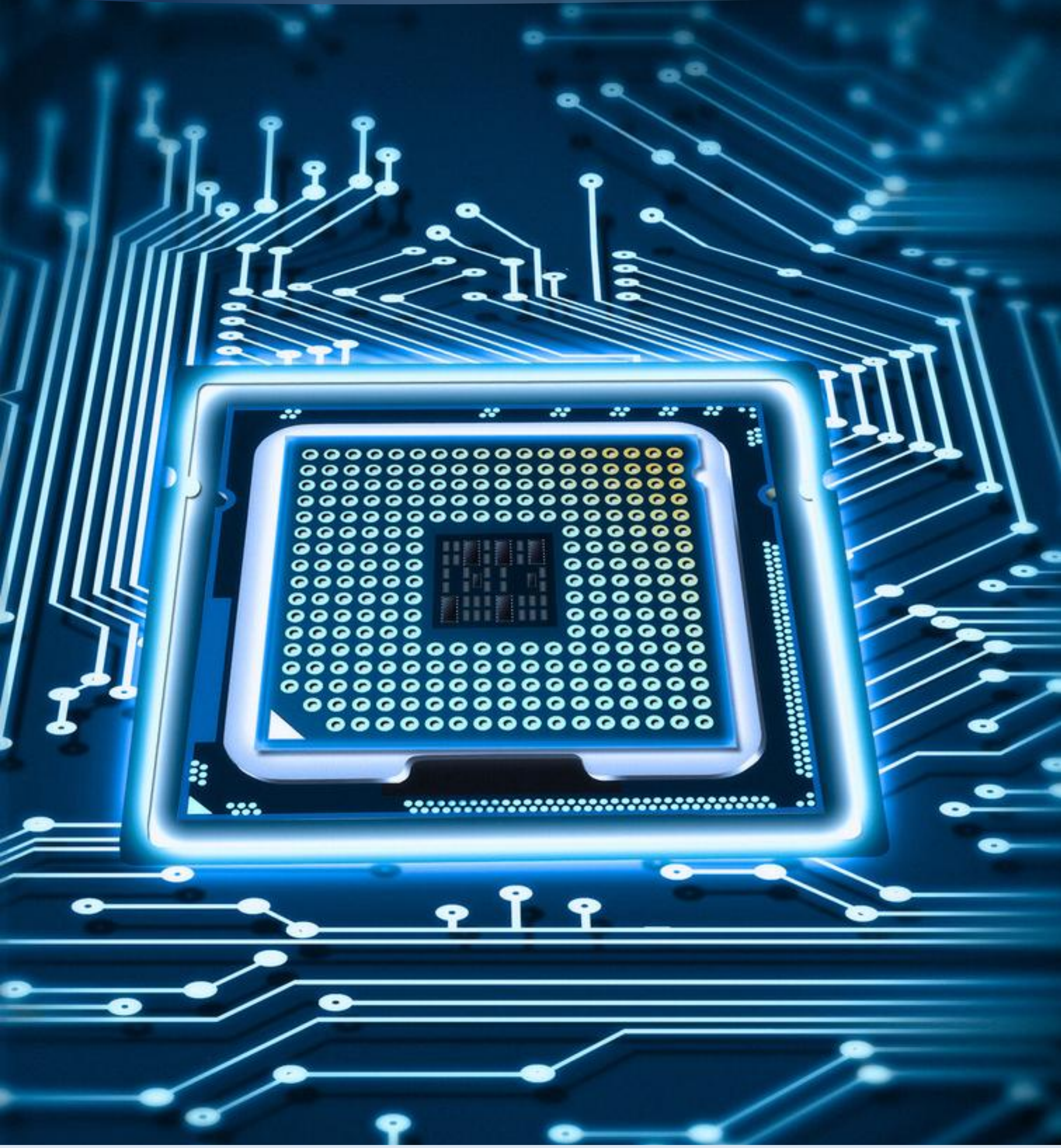
National Semiconductor Strategy



MINISTRY OF
INDUSTRY AND TRADE

Office of the Government
of the Czech Republic

MINISTRY OF INDUSTRY AND TRADE

Ministry of Industry and Trade of the Czech Republic

Prague 2024

Opening remarks by the Minister

Dear readers,

We are entering an era of unprecedented technological change, driven by the exponential growth of digitalisation. Semiconductors, miniature electronic components, are becoming the heart of the modern world and are essential to the functioning of smartphones, computers, cars and countless other devices. In this dynamic sector, the Czech Republic has a unique opportunity to become one of Europe's leaders and strengthen its technological sovereignty.

The National Semiconductor Strategy of the Czech Republic is an ambitious plan to transform our semiconductor sector and ensure its continued growth and prosperity.

The strategy aims to triple the size of the semiconductor sector in the Czech Republic by 2029. This should be achieved through the implementation of this comprehensive material, which includes support for research and innovation, talent development, export and investment stimulation and improved business conditions. The National Semiconductor Strategy builds on the European Chip Act, which the Czech Republic not only helped to negotiate, but is also actively engaged in building a strong and resilient European semiconductor industry, reducing dependence on imports of key components and technologies and supporting the development of domestic capabilities for research, development and manufacturing of chips.

The implementation of the National Semiconductor Strategy will require the efforts and cooperation of all stakeholders - government, relevant ministries, industry partners, academia and the general public. The government will play a key role in coordinating the implementation of the strategy and promoting investment, while industry will be responsible for the implementation of specific projects and innovations. Academic institutions will play an important role in research and development and in training talented professionals. We cannot forget cooperation with international partners, which will be essential for sharing knowledge and experience and, in particular, for building strong strategic partnerships.

The strategy is based on a detailed analysis of the current state of the sector, takes into account the recommendations and experience of foreign partners and the European Commission, and is based on market forecasts and analyses of future trends in this important sector.

The National Semiconductor Strategy represents an ambitious but achievable vision for the future of the Czech semiconductor sector. Implementation of this strategy has the potential to transform the Czech economy, strengthen the country's technological sovereignty and ensure prosperity for future generations. Together, we can turn this vision into reality and make the Czech Republic a leader in the global technology industry.

Ing. Jozef Síkela

Minister of Industry and Trade of the Czech Republic

Acknowledgements

The Ministry of Industry and Trade of the Czech Republic, together with its partners, the Office of the Government of the Czech Republic and the Ministry of Education, Youth and Sports of the Czech Republic, would like to thank its industrial partners, in particular the Czech National Semiconductor Cluster, z.s., the Confederation of Industry of the Czech Republic and the Chamber of Commerce of the Czech Republic, for their expert consultations and supplementation of the strategy. We would also like to thank the representatives of the academic community and regional partners.

Managerial summary

The National Semiconductor Strategy focuses on the position of the Czech Republic in the semiconductor value chain in the current context both at the European level and in the global context. The aim of the strategy is to strengthen the semiconductor sector in the Czech Republic by proposing measures to strengthen the position of the Czech Republic in the semiconductor value chain.

One of the key arguments for the development of semiconductor technologies is to ensure greater independence and reduce the risk associated with the geographical location of production plants. Nowadays, most of the manufacturing plants are located in Southeast Asia, especially in Taiwan. However, Taiwan is under constant pressure from the People's Republic of China, which is also causing tensions in the South China Sea, one of the main arteries of global trade. A possible conflict in this area would have far-reaching consequences for the world economy. It is therefore advisable to strengthen the strategic autonomy of the European Union, and hence of the Czech Republic. In addition to strengthening technological sovereignty, the strategy is therefore also aimed at transforming the Czech economy towards higher added value. A specific feature of the semiconductor sector is that it is characterised by a high level of involvement of research and development results. This is linked to the high added value achieved by the sector, which exceeds the added value generated by many other sectors of the manufacturing industry.

The strategy builds on the European Chip Act and defines steps to strengthen the Czech Republic's position in the European semiconductor ecosystem. In contrast to some EU countries, such as Germany, the Czech Republic does not yet have such a well-developed semiconductor sector, but it has a good foundation that can be developed.

The strategy aims to triple the size of the semiconductor sector in the Czech Republic by the end of 2029. In order to achieve this main goal, five strategic areas are defined and for each area a specific strategic goal is to be achieved. The strategic objectives are further broken down into specific objectives and individual measures that are necessary to achieve the main objective of the strategy. The first strategic objective is to implement the measures defined in the European Chips Act by the end of 2026. In particular, the establishment of a national competence centre to serve as an entry point into the European ecosystem of support for research, development and innovation in the semiconductor sector. It is also about the cooperation of the centre with pilot lines and the allocation of funds for investment incentives, including the preparation of investment-ready areas. The second strategic area focuses on export promotion. The aim is to increase the share of advanced technologies in the Czech Republic's exports by 200% compared to 2022. To do this, it is necessary to find new markets and promote Czech semiconductor companies there. The third strategic area is focused on supporting research and development, where we want to support research by excellent scientific teams and increase the resources directed to applied research in the semiconductor sector. The fourth strategic area is aimed at increasing the talent pool in the semiconductor sector in the Czech Republic. The aim is to triple the number of experts in the Czech Republic by the end of 2029. This should be done not only by promoting education, but also by continuing and deepening the targeted migration policy. The recruitment of skilled workers from third countries is still perceived by employers as relatively complicated and lengthy, despite a number of changes (government economic migration programmes, phasing out of labour market tests, planned digitalisation, etc.), which may negatively affect their ability to attract talent from third countries. The fifth strategic area focuses on promoting entrepreneurship in the semiconductor sector. In addition to support for start-up companies, measures are defined to support the internationalisation of Czech SMEs, improve conditions for foreign investors or support the introduction of innovative products on the market.

Overall, the National Semiconductor Strategy is based on a detailed analysis of the Czech semiconductor sector, recommendations of foreign partners and their experience, and predictions of future developments and is conceived as a system of specific interrelated measures, the implementation of which leads to clearly defined measurable objectives, including risk assessment and quantification of impacts on the state budget. It should also be noted that the material is designed so that, if assessed positively, the contribution to public budgets in the long term will be significantly positive.

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INTRODUCTION

The need for a strategy

In recent years, the production of semiconductor components has come to the fore globally due to the disruption of supply chains. This was initially due to the natural disasters in Asia and subsequently due to the constraints caused by the covid-19 disease pandemic. The combination of production capacity disruptions with the increase in demand for semiconductors has caused shortages of these components in many sectors. One of the most affected sectors was the manufacturing industry, in particular the automotive sector, which in many cases had to resort to production shutdowns. However, the shortage of semiconductor components is not only a major problem in the automotive industry. Semiconductor components are now found in almost all devices, from household appliances to medical technology. Their shortage can cause widespread problems across society. Semiconductor technologies are also a research, technology and security priority for many governments, as can be demonstrated by the restrictions on their export to some countries.

One of the key arguments for the development of semiconductor technologies is to ensure greater independence and reduce the risk associated with the geographical location of production plants. Nowadays, most of the manufacturing plants are located in Southeast Asia, especially in Taiwan. However, Taiwan is under constant pressure from the People's Republic of China, which is also causing tensions in the South China Sea, one of the main arteries of global trade. A possible conflict in this area would have far-reaching consequences for the world economy. It is therefore advisable to strengthen the strategic autonomy of the European Union and, by extension, the Czech Republic.

Another key argument is the transformation of the Czech economy towards higher added value. The semiconductor sector is characterised by a high level of involvement of R&D results. This is linked to the high added value achieved by the sector, which exceeds the added value generated by many other industrial sectors. In particular, the National Semiconductor Strategy should help to strengthen the position of the Czech Republic and increase its competitiveness in Europe.

It is equally important to implement the measures contained in the Regulation of the European Parliament and of the Council establishing a framework for measures to strengthen the European semiconductor ecosystem (the Chip Act) and accompanying regulations.

The security aspect should also be mentioned. Semiconductor technologies were included in the Commission Recommendation of 3 October 2023 on areas of critical technologies for the economic security of the EU.

Purpose of the strategy

The purpose of the National Semiconductor Strategy is to provide a comprehensive framework for the development of semiconductor technologies in the Czech Republic. This framework should include concrete steps to improve the strategic position of the Czech Republic and its value chain. The aim is to remove the blocking factors for further strengthening of the sector. In particular, the strategy should focus on human resource development and support for research, development and innovation. The strategy also emphasises the importance of promoting cooperation between the scientific community, private actors, educational institutions and the public sector in order to maximise the potential of semiconductor technologies for the economy and society.

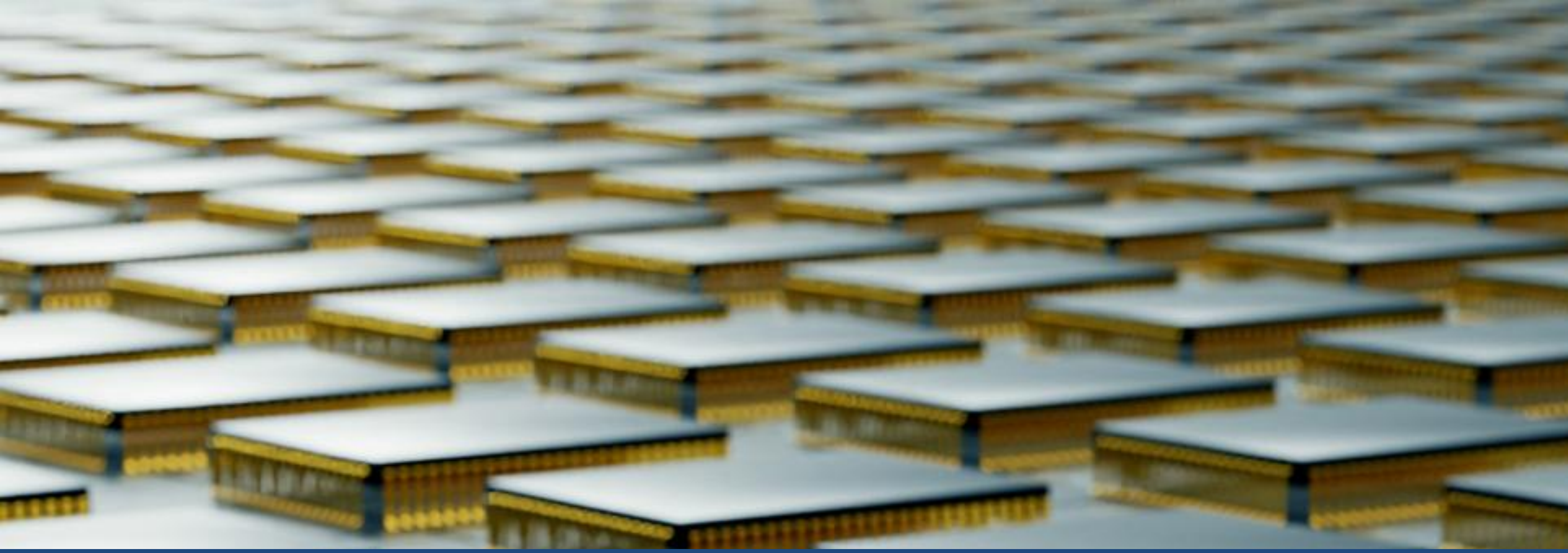
Focus of the strategy

The presented strategy addresses semiconductor value chain technologies with a focus on IP design, EDA tools, integrated circuits, discrete power devices and modules for their encapsulation. In addition to the ICs themselves, the strategy also addresses the facilities used to manufacture and test them. This strategy is not focused on semiconductor technologies in photovoltaic panels and other semiconductor applications outside the domain of manufacturing and testing integrated circuits (chips) and discrete semiconductor components. This delimitation has been established on the basis of approved European legislation - the *Chip Act*. It does not go into detail on quantum computers and other quantum technologies, which are the subject of the National Quantum Strategy.

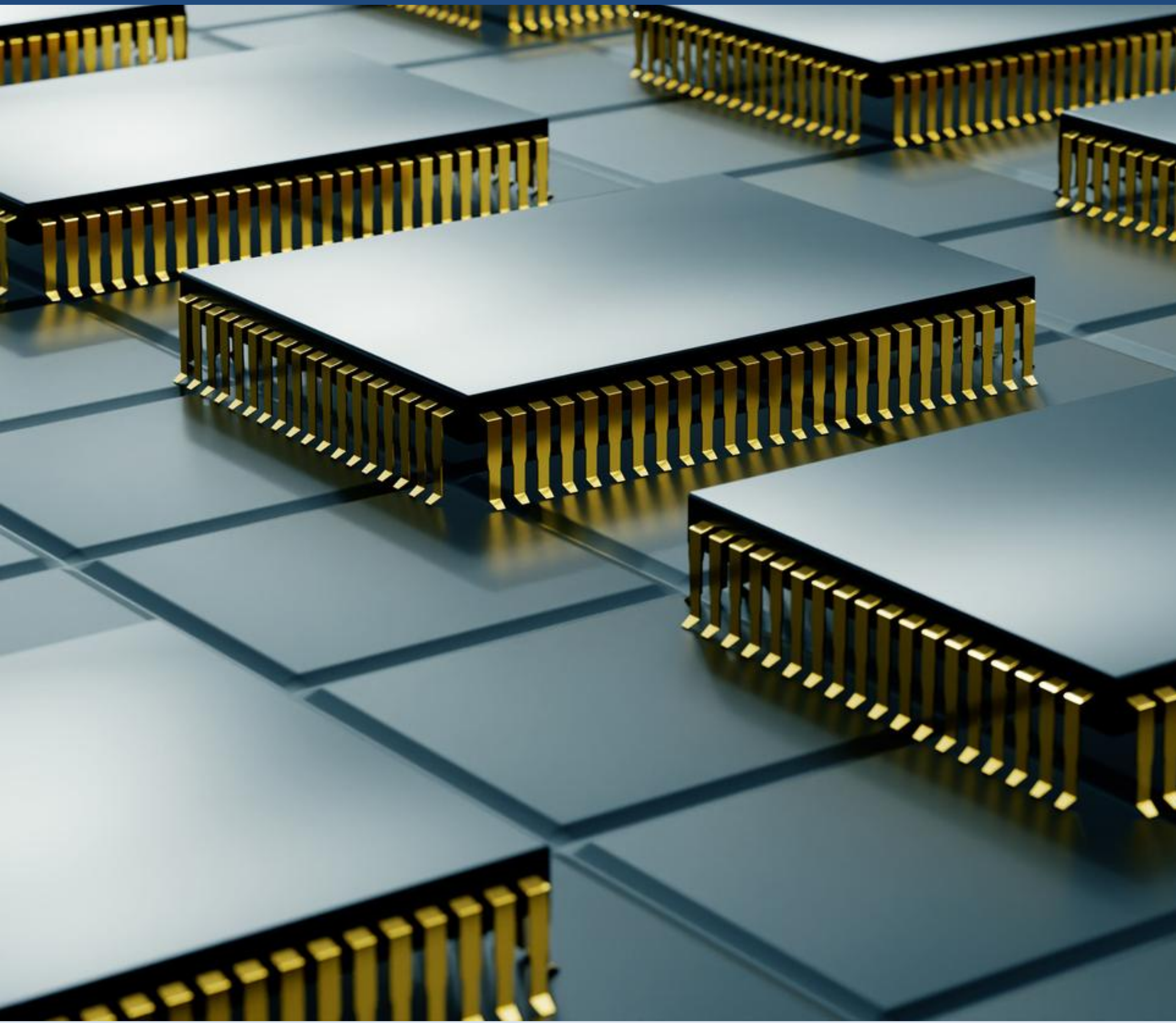
Objective of the strategy

The strategy aims to strengthen the semiconductor sector in the Czech Republic. It is also through the implementation of the measures defined in the Chip Act and its follow-up activities.

This strategy, together with the National Quantum Strategy and the National AI Strategy, is one of the three basic strategies of the Czech Republic for Emerging and Key Technologies. Together they form the cornerstone on which the future development of the Czech Republic in the 21st century can be built.



PLACING THE STRATEGY IN AN INTERNATIONAL CONTEXT



PLACING THE STRATEGY IN AN INTERNATIONAL CONTEXT

Currently, the leader in the production of "microchips" is Taiwan, which has the most advanced chip manufacturing technologies. In the area of the most advanced manufacturing processes, it has a dominant market position (market share of over ⅔, in some segments up to 90%). The next major player is South Korea, where the rest of the production capacity of the most advanced manufacturing processes and most of the memory production capacity is located. The US, on the other hand, has the most developed integrated circuit design segment and is also capable of producing very advanced logic and memory chips. Chinese manufacturers are not yet able to replicate the most advanced manufacturing processes, but China has a significant share of production using already established manufacturing processes (30%). Market share is expected to grow to 40% by the end of the decade. Therefore, both the US and the EU intend to start monitoring the dependence on China for microelectronics.

Notified public aid

The chapter describes the announced support for the semiconductor sector in the US, China, South Korea, Japan, the UK and Israel.

USA

In the US, the federal CHIPS and Science Act was passed on 9 August 2022. The Act allocates $52.7 billion in public funds to support semiconductor research and manufacturing ($158.78 per capita). The Act includes $39 billion in subsidies for chip manufacturing on U.S. soil. In addition, tax credits of 25% are contemplated for investments in manufacturing equipment costs and $13 billion for semiconductor research. These activities are intended to strengthen the resilience of the US supply chain and, in particular, to counter Chinese competition in the semiconductor sector. In this context, there is also a $174 billion investment in the overall public sector R&D ecosystem, including NASA, the Department of Energy (DOE) and the National Institute of Standards and Technology (NIST).

The impact of the CHIPS and Science Act is not yet clear. According to some analytical outputs (Semiconductor Industry Association - SIA), 50 projects worth about 200 billion dollars can be expected (SIA, 2022).

People's Republic of China

The People's Republic of China has already announced (Reuters) that it intends to support the domestic semiconductor sector with 1 trillion yuan (about $143 billion, $101.27 per capita) in 2022. This initiative was complemented in 2023 (Reuters) by a 300-million-yuan (c. $41 billion, $29.04 per capita) state fund to support the semiconductor industry. However, it is not clear from public sources whether the new fund is part of or in addition to the originally announced support.

South Korea

South Korea is offering tax incentives as early as 2021. Prime Minister Moon's administration has introduced tax incentives for investment in semiconductor R&D of up to 50% if a company invests more than 100 billion won (about $75 million). For the same amount of investment in semiconductor-related equipment, an investment incentive of up to 20% was available. A special investment fund worth 1 trillion won was also established, which is about 750 million dollars - $14.50 per capita (Donga Ilbo, 2021).

These investment incentives were followed up by Prime Minister Yoon's administration, which passed the K Chips Act in 2023. This increases tax credits for investments in semiconductor manufacturing facilities to 25-

35% and for R&D investments to 30-50%. For these investment incentives, a company must design or manufacture advanced semiconductor components (The Diplomat, 2023).

Japan

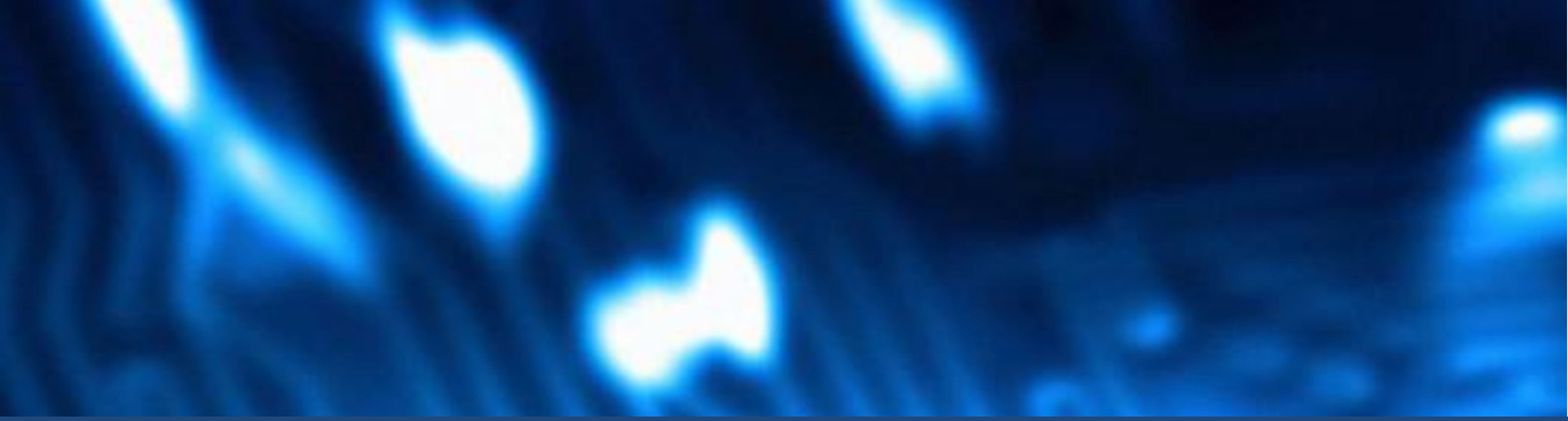
Japan announced (Reuters, 2023b) a 2 trillion yen (about $13 billion, $103.42 per capita) boost to its domestic semiconductor sector.

United Kingdom

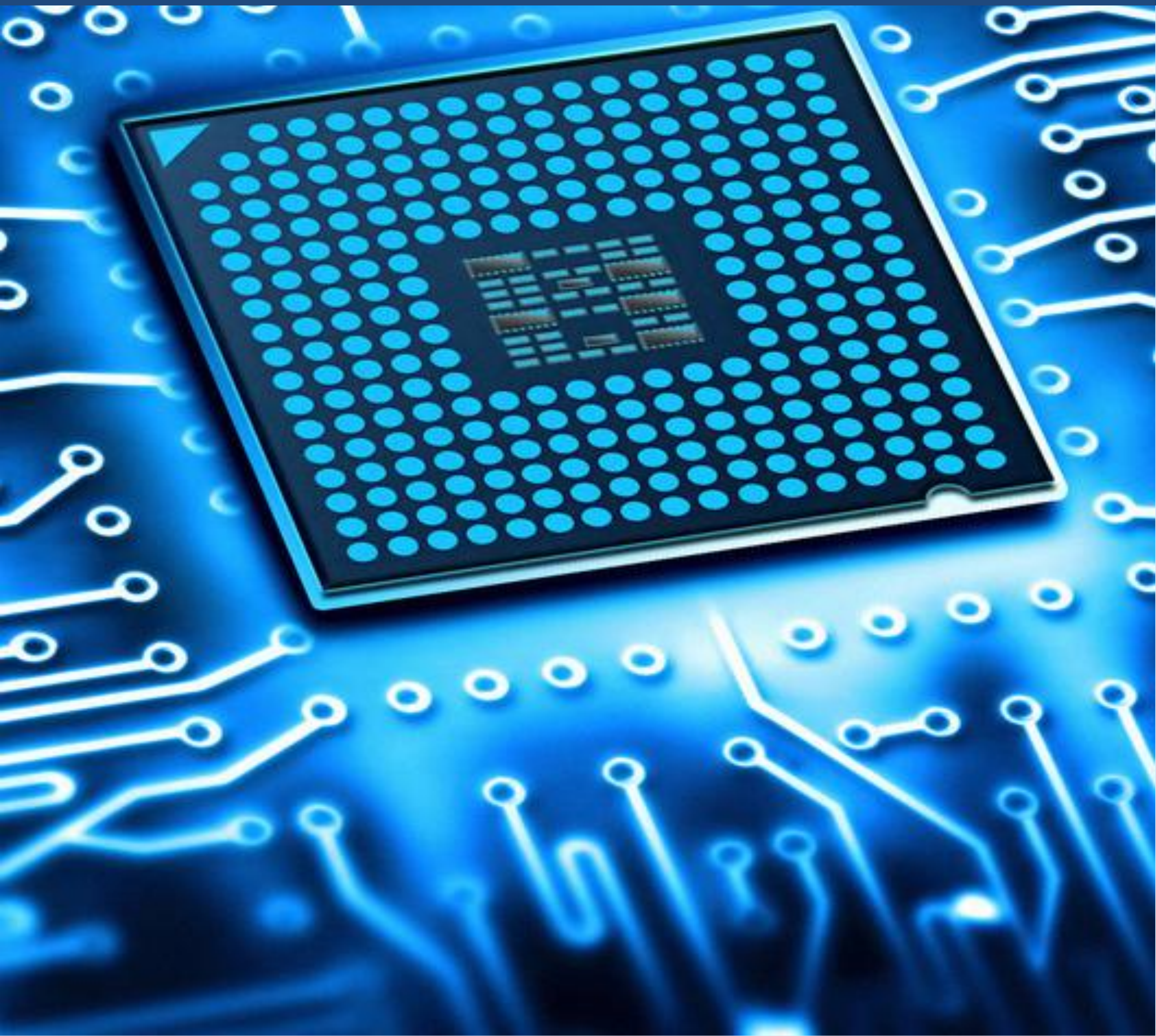
The UK (Reuters, 2023c) plans to support the sector with a total of £1 billion ($1.3 billion, $19.31 per capita). The UK government has also developed a National Semiconductor Strategy (Gov.uk, 2023). The strategy has three main objectives. To support the domestic semiconductor sector, to mitigate the risk associated with supply chain disruption and to ensure national security.

Israel

Israel has pledged a $3.2 billion investment incentive for a new Intel plant ($341.73 per capita), according to Reuters (2023d). This is Intel's next investment in the country. Intel has about 10% of its global workforce allocated in Israel.



PLACING THE STRATEGY IN THE EUROPEAN CONTEXT



PLACING THE STRATEGY IN THE EUROPEAN CONTEXT

The chapter introduces the continuity of the National Semiconductor Strategy of the Czech Republic with strategic initiatives, EU regulations and also places it in the context of public aid notified in other EU countries.

European Digital Decade

The Digital Decade initiative was already introduced in 2020. The approach and roadmap with clearly defined goals and principles for 2030 was set out in the Digital Compass Communication, which presents the vision and pathways for the EU's digital transformation by 2030 in four main areas: digital skills, digital infrastructure, digital transformation of businesses and digitisation of public services. The aim is to accelerate the Union's digital transformation and ensure that it is in line with EU values, to strengthen digital leadership while promoting inclusive, transparent, open and sustainable digital policies that are people-centred, based on fundamental rights and accessible to all.

To deliver on this shared vision, Decision (EU) 2022/2481, which establishes the Digital Agenda 2030, sets out a joint commitment by the European Parliament, the Council, the Commission and the Member States to work together and move in a common direction to achieve the EU's digital transformation. The Decision sets out the general objectives and specific digital targets to be achieved by the EU by 2030 in four main areas: digital skills, digital infrastructure, digital transformation of businesses and digitisation of public services.

One of the digital infrastructure objectives is also to produce high-end semiconductors in the Union, in line with Union law on environmental sustainability, which in value terms amounts to at least 20% of global production. Based on Decision (EU) 2022/2481, Member States have developed national strategic plans (roadmaps), which will be regularly updated and map the implementation of the Digital Decade objectives. In particular, according to the European Commission's instructions, Member States should set their national targets and trajectories to contribute to the common commitment.

The Czech Republic developed this national strategic plan in 2023 (approved in November 2023), entitled "The Road to the European Digital Decade: A Strategic Plan for the Digitalisation of the Czech Republic by 2030". The Roadmap contains, among other things, national trajectories that describe the implementation of the Key Performance Indicators (KPIs) set by the Commission Implementing Decision (EU) 2023/1353 and which are based on the digital objectives. Another important part of the document is the individual measures that support the achievement of the digital objectives. In the current version of the Roadmap, a trajectory for semiconductors is not developed due to lack of data (an EC study on this topic is currently underway). The next update of the Roadmap, which should already include the trajectory, is planned for the second half of 2024.

European Industrial Strategy

With the release of the New Industrial Strategy for Europe on 10 March 2020, the European Commission confirmed the crucial role of industry for the EU economy and the need for coherence between all related EU policies. The strategy aims to boost the competitiveness of European industry in global markets and the EU's strategic autonomy, and to help European industry manage the dual transformation to climate neutrality and digital leadership.

The Commission identifies key actions in seven areas: the single market; a global level playing field; supporting industry towards climate neutrality; the circular economy; industrial innovation; skills; investing in transformation.

In the wake of the COVID-19 pandemic, the European Commission also updated this document in 2021 with an emphasis on addressing the resilience of the European internal market and strengthening strategic autonomy, including a focus on semiconductor technologies.

European Chip Act

The European Chips Act, which the Czech Presidency helped negotiate, is a significant contribution to European independence from Asian dominance in semiconductor technology. The ECA itself and its Chips for Europe initiative, which aims to increase semiconductor production on the continent, is a challenge for the entire European semiconductor industry and a great opportunity for the Czech semiconductor industry.

The aim of the Chip Act is to more than double the EU's share of global production of state-of-the-art semiconductors to 20% by 2030, thereby ensuring the resilience of the European semiconductor supply chain. The Chip Act is intended to strengthen the EU's position, in particular in research, chip design and to mobilise investment in European chip production. It should also attract new talent and encourage the creation of a skilled workforce. A follow-up monitoring and crisis management system should stabilise the sector and intervene in the event of production failures.

The European Chip Act alone is expected to secure additional public and private investment of over €15 billion, complementing: existing programmes and actions on semiconductor research and innovation such as Horizon Europe and the Digital Europe programme[1] , announced support from Member States. In total, the Chip Act will support over €43 billion of investment by 2030 under this policy, which will be similarly complemented by long-term private investment.

To achieve this vision, the European chip strategy is divided into five strategic objectives under three pillars:

Pillar 1 - "Chips for Europe" initiative: serves to strengthen the European Union's leadership in research and technology. It also aims to build and strengthen in-house capacity for innovation in EDA tools, integrated circuit design, manufacturing, testing and encapsulation of advanced chips and their transformation into commercially available products. Furthermore, the pillar should address the acute skills shortage, attract new talent and foster the emergence of a skilled workforce. The measures will be implemented through the Chips Joint Undertaking (Chips JU).

Pillar 2 - Security of supply and resilience: aims to put in place an appropriate framework to substantially increase the EU's generation capacity by 2030 by setting public support conditions (investment incentives).

Pillar 3 - Monitoring and crisis response: focuses on understanding global semiconductor supply chains by monitoring them. To this end, I will set up a coordination mechanism between Member States and the European Commission to map and monitor the EU semiconductor sector. The Pillar 3 framework should also be used in the event of a crisis shortage of semiconductor components.

The most significant in terms of support from European money is Pillar 1 (the Chips for Europe Initiative), which is to establish three basic components - a design platform (EDA, IP), pilot lines and a network of competence centres.

The European Network of Competence Centres for Semiconductors is established as a comprehensive network of non-profit organisations carrying out activities for the benefit of Union industry, in particular SMEs, as well as research and technology organisations, universities, the public sector. They provide access to the other components of the first pillar (design services, development tools and pilot lines). They also

[1] The Digital Europe (DIGITAL) programme provides strategic funding to address these challenges and supports projects in key areas of capacity such as: supercomputing, artificial intelligence, cyber security, advanced digital skills and ensuring the widespread use of digital technologies across the economy and society. In September 2023, a new capacity area for semiconductors was added. According to the eyewash act, DIGITAL funding was mobilised to address the semiconductor shortage by supporting capacity building through the Chip for Europe initiative.

provide know-how, transfer expertise between Member States and regions, organise training events, develop talent and increase the number of students and the quality of education up to the level of doctoral studies in the Union.

A Member State expert group is currently working on the implementation of important ECA links within the Member States, focusing in particular on support for competence centres, pilot lines, building first-of-a-kind advanced fabs and mapping and monitoring crisis areas in the European semiconductor supply chain. This common platform is represented by the European Semiconductor Council.

IPCEI

Significant support for research and development as well as for the first industrial application is also provided at EU level in the so-called Important Projects of Common European Interest (IPCEI). The second IPCEI in the field of Microelectronics and Communication Technologies also involves projects from the Czech Republic (see Annex 4 for more details). The project was successfully notified in 2023 and is currently under implementation. Public support at European level of €8.1 billion is complemented by additional private resources of €13.7 billion and 14 Member States are involved with 68 R&D projects including first industrial deployment. In addition, a total of more than 600 indirect partners are involved. This makes IPCEI Microelectronics and Communication Technologies the most successful project of its kind.

European Critical Raw Materials Act

This regulation focuses, among other things, on raw materials that are essential for technologies and products of strategic importance, including semiconductor technologies. Electric cars, solar panels and smartphones all contain critical raw materials and, for the time being, the EU is dependent on certain raw materials. Critical raw materials are key to the green and digital transformation and securing their supply is essential for the economic resilience, technological leadership and strategic autonomy of the European Union. Russia's war against Ukraine and China's increasingly aggressive trade and industrial policy have also made cobalt, lithium and other raw materials a geopolitical factor.

With the global transition to renewable energy and the digitisation of economies and societies, demand for these strategic raw materials will increase rapidly in the coming decades. In addition to the updated list of critical raw materials, the Regulation sets out a list of strategic raw materials that are essential for technologies that are critical to Europe's green and digital ambitions. The Regulation enshrines the lists of these critical and strategic raw materials in EU law and sets criteria for domestic capacities along the entire supply chain of strategic raw materials by 2030.

Education

Czech higher education is part of the wider European area. It therefore also strives for compatibility with tertiary education in other European countries. In 2021, the Council of the EU issued a *Council Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030)*, which emphasised the importance of education and training for the future of Europe, to make society and the economy more cohesive, inclusive, digital, sustainable, green and resilient. One of the strategic priorities is accessible lifelong learning and mobility for all EU citizens. Another strategic priority is to strengthen European higher education, which should aim, inter alia, for closer cooperation, knowledge and resource sharing. By 2030, the share of 25–34-year-olds with tertiary education should be at least 45%.

In 2022, the Council of the EU issued its recommendation on a *European approach to micro-credentials for lifelong learning and employability*. The document discusses the growing need to update and improve the knowledge, competences and skills of Europe's population to fill the gap between their formal education, training and the needs of a rapidly changing society and labour market. The coronavirus pandemic, the digital and green transitions have accelerated the pace of change, the way we learn and work, and Europe's citizens need to be prepared to meet current and future challenges. One solution is micro-certificates, which will help certify the results of small, narrowly focused learning experiences. Where appropriate, micro-certificates can complement existing qualifications, providing added value without undermining the fundamental principle of complete curricula in initial education and training. The Council of the EU has therefore recommended that Member States introduce micro-certificates to enable individuals to acquire or update acquired knowledge, skills and competences. The MoEYS has responded to this recommendation in its strategic plan as outlined above.

The Council of the EU has also issued a Recommendation on tracking graduate employability (*The Council Recommendation on tracking graduates, 2017*). The document recommends that Member States improve the availability and quality of data on student and graduate activity so that countries have an idea of people's transition into the labour market, into further education and their career pathways. The aim is for public authorities to link data from different sources in an anonymous way to build a comprehensive picture of graduate outcomes.

The European Union also co-funded a METIS project (2021) which looked at the current skills gap in the microelectronics industry and lists policy recommendations. In particular, it suggests setting up lifelong learning programmes, courses designed jointly with industry, involving industry experts in university teaching or developing an internship programme. The project also mentions the need to promote the sector and lists the positions in demand and the skills needed or the need to work with clusters to increase dialogue between industry and educational institutions. In addition to formulating policy recommendations, the project also aimed to design a system of training courses and their content. The project also proposes the establishment of a single EU-wide online learning platform, which would include a portfolio of micro-curricula ("EU Chip Academy").

Notified public aid within the EU

The chapter lists notified public support to the semiconductor sector in Germany, France, Italy, Spain, the Netherlands and Poland.

Germany

According to Bloomberg (2023), the German government plans to provide €20 billion (€240.38 per capita, $22 billion) in public support from the Climate and Transformation Fund to subsidise chip projects by Intel Corporation, TSMC, Infineon Technologies, Bosch, NXP Semiconductors and ZF Group/Wolfspeed.

France

According to Reuters (2023e), France plans to invest €5.5 billion (€81.18 per capita) in the semiconductor sector by 2030. This includes the promise of a €2.9 billion investment incentive for a joint venture between STMicroelectronics and GlobalFoundries to build a factory in Crolles in south-eastern France.

Netherlands

The Netherlands wants to invest €2.51 billion (€141.8 per capita) in the Beethoven project, which aims to boost the development of the semiconductor sector around Eindhoven (Government of the Netherlands, 2024). The project will support talent development with €450 million until 2030. Thereafter, EUR 80 million per year should be invested in talent development. Further funds will be spent on infrastructure improvements. The government will support infrastructure investments with €718 million and the region with €340 million.

Italy

According to Reuters (2023f), Italy intends to support strategic sectors, including microelectronics, with €1 billion (€16.92 per capita). But at the same time, according to Porsche Consulting (2023), Italy has already offered an investment incentive to Intel worth €1.8 billion (€30.45 per capita).

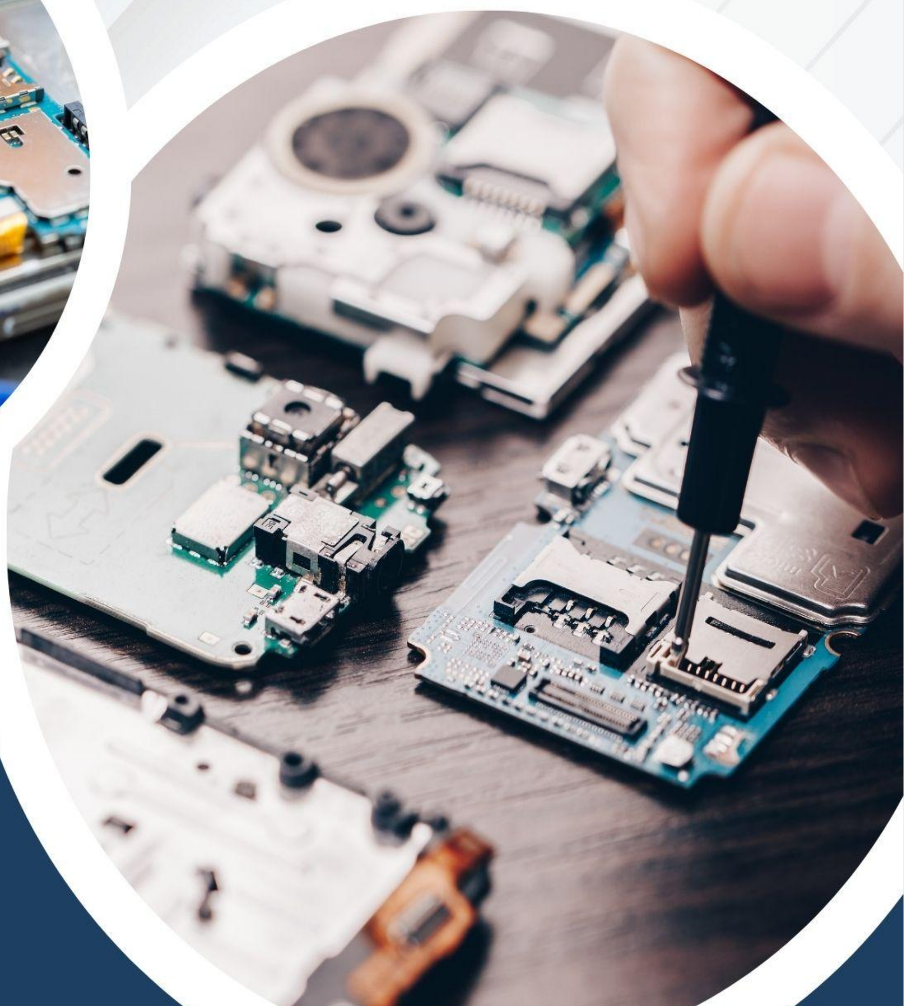
Spain

The Spanish government has presented (Reuters, 2022b) a plan to support the semiconductor sector with €12.25 billion (€258.33 per capita) by 2027. €9.3 billion (€196.12 per capita) is to be allocated to support the construction of factories, €1.1 billion to support research and development (€23.20 per capita) and €1.3 billion to support integrated circuit design (€27.41 per capita). Spain also intends to support start-ups and scale-ups with €200 million (€4.22 per capita) to be put into a fund to support them.

Poland

Poland has announced a plan to support the sector with 7 billion zlotys (approx. €1.6 billion, €42.38 per capita) by 2026 (PwC, 2024).

SETTING THE STRATEGY IN THE NATIONAL CONTEXT



SETTING THE STRATEGY IN THE NATIONAL CONTEXT

The chapter describes how the National Semiconductor Strategy relates to legislation and strategic direction in the areas of research, development and innovation, education, economy and security. It also outlines the existing public support for this sector in the Czech Republic.

Legislative anchoring

On 21 September 2023, a European regulation called (for short) the Chip Act came into force. For the implementation of the Regulation in the Czech Republic, a draft Act on national authorities in the field of semiconductors and certain activities performed by them has been prepared. It provides that the competent national authority is the Ministry of Industry and Trade, which is also the single contact point that will perform the liaison function to ensure cross-border cooperation with the competent national authorities of other Member States, the Commission and the European Semiconductor Council. To ensure the application and implementation of Articles 3 to 12 of the Chip Act, the Ministry of Education, Youth and Sports (MoEYS) is the competent national authority. This division implies that the MoEYS will in effect carry out the responsibilities of the Chips for Europe initiative, including the exercise of competences in relation to the European Network of Competence Centres for Semiconductors. The remaining responsibilities will be carried out by the MIT. This division of responsibilities is also reflected in the National Semiconductor Strategy.

Strategic direction of the Czech Republic

Research, development and innovation

The overarching document in this area is the National R&D&I Policy of the Czech Republic 2021, which includes, for example, the objective of the National R&D&I Policy 5.6 "To support enterprises, research organisations and the public sector in joint research based on modern technologies (5G networks, AI, VR/AR); to support, as a priority, projects strengthening the specialisation of the product chain with high added value."

The key strategy for industrial research, development and innovation is the National Research and Innovation Strategy for Intelligent Specialisation of the Czech Republic 2021-2027 (National RIS3 Strategy). The strategy states that new opportunities should be exploited and thus the creation and development of new companies. The RIS3 Strategy addresses the issue both in the horizontal priority Digital Agenda, but also across vertical priorities - domains of specialisation. The most relevant is the specialisation domain Electronics and Digital Technologies, but the topic is also intertwined with other specialisation domains (Green Transport, Technologically Advanced and Safe Transport, Advanced Medicine and Pharmaceuticals, Advanced Materials, Technologies and Systems, Digitisation and Automation of Production Technologies). The semiconductor theme is also linked to the new RIS3 strategy priorities formulated in the RIS3 missions (e.g., Making the economy more material, energy and emissions efficient and strengthening societal resilience to security threats), as without their application it would not be possible to innovate in solutions to meet the objectives of these missions.

Among the strategic topics of R&D&I we can mention, for example, areas such as Electronics and digital technologies for Industry 4.0; Engineering production techniques and technologies; Safe and reliable nuclear energy, preparation of next generation nuclear sources; Smart grids - transmission and distribution systems, etc.

The following have been identified by the European Commission as Key Enabling Technologies (KETs): Advanced Manufacturing Technologies, Advanced Materials and Nanotechnologies and Biotechnologies, Photonics and Micro/Nanoelectronics, Artificial Intelligence and Digital Security and Connectivity. The National RIS3 Strategy also works with these key technologies. Research and innovation themes in semiconductors cover virtually all key technologies, but in particular micro/nanoelectronics, which deals with highly miniaturised semiconductor devices, components and electronic subsystems, and includes the broad area of semiconductors and semiconductor devices, chips, microprocessors and their integration into larger assemblies, products and systems.

Another strategy for research, development and innovation is the Innovation Strategy of the Czech Republic 2019-2030, which was approved by the Government in 2019. It is a strategic framework plan that predetermines the government's policy in the field of research, development and innovation and is intended to help the Czech Republic to become one of the most innovative countries in Europe within twelve years.

In 2012, the Government also approved the National Priorities for Oriented Research, Experimental Development and Innovation. However, due to the age of the materials, these priorities no longer fully reflect current technological developments. Especially in areas such as AI, quantum technologies or semiconductor technologies. However, the objectives defined in the material are partly relevant for the following areas: adapting to new technologies, achieving a consistently high degree of data protection and communication security in a dynamically changing environment, expanding the use and improving the quality of automatic control and robotics, electrical and magnetic mapping and stimulation, navigation and robotic systems, neurostimulators, Refinement and control of invasive techniques, development of ICT, telematics and cyber protection of ci, improvement of security information acquisition and classification systems, analysis of security information, development of new weapon and defence systems, development of communication and information systems and cyber defence, increase safety and reliability of processes using simulation and virtual reality tools so, to achieve significant reductions in direct and indirect costs associated with their failure, capacity, reliability and security of electricity backbone transmission networks, modification of networks for demand-side management, electricity storage including hydropower, security and resilience of distribution networks, research and development of new energy-efficient industrial technologies, advanced materials for competitiveness, and use of nanomaterials and nanotechnologies."

Education

The main strategy for the education sector is the Education Policy Strategy of the Czech Republic 2030+ from 2020, which states that complex skills, multidisciplinarity and computational thinking will become increasingly important. However, the focus of education on specific areas is not mentioned in the strategy.

In 2020, the Ministry's Strategic Plan for the Higher Education Sector for the period from 2021 was issued. The Strategic Plan contains six priority objectives, which are further divided into specific operational objectives and measures, some of which correspond to the objectives set out in the National Semiconductor Strategy. The Strategic Intent is followed by the Strategic Intent Implementation Plan for the Higher Education Sector for that year. Thus far, Implementation Plans have been developed for 2022, 2023 and 2024. The third related document is the Strategy for the Internationalisation of Higher Education for the period from 2021.

One of the six priority objectives set out in the Strategic Plan is "To develop competences directly relevant to life and practice in the 21st century". The aim is that the proportion of young people completing tertiary education should not fall and should exceed 35 % by 2030, approaching the EU average. In addition, one third of bachelor and master graduates should graduate in professional profile programmes. The preparation of these study programmes will be closely linked to practice and cooperation with employers. At the same time, these study programmes should not be subordinated to the particular interests of specific enterprises and should prepare students for the future development of the labour market. However, the emphasis on practical application will not be the preserve of vocational programmes alone, but the requirement to acquire practical skills and to be ready to enter the labour market is also placed on academic programmes. The MoEYS will therefore continue to collect data on graduate employability so that the higher education system can be tailored to the needs of society on the basis of this data. The strategic plan further states that the MoEYS will support the creation of new and the modernisation of existing study programmes in areas where significant social demand for graduates is identified. In developing new programmes, emphasis will be placed on cooperation with practice and the use of modern educational methods. The MoEYS will also support cooperation with secondary schools, both with regard to supporting learners and to setting appropriate conditions for the transition between the two levels of study. The Ministry will also support the sharing of experience between universities in the field of work placements and internships, including their contractual and organisational arrangements and quality assurance. At the same time, emphasis will be placed on strengthening the internationalisation of Czech higher education to make it more attractive for talented students from abroad.

Furthermore, the Ministry of Education and Science aims to increase the number of people taking at least one lifelong learning course each year. Lifelong learning also helps people adapt to social, economic, technological or environmental changes. A recommended format for a certificate of completion of a lifelong learning course will be developed, which will include information on the hours and credits of the course and the learning outcomes achieved. In its development, the MoEYS will draw on the Common Micro credential Framework adopted by the European MOOC Consortium. The recommendations will include the awarding of credits in courses where this is not common practice today.

Economics

The Czech Republic's Economic Strategy and Economic Security Strategy are currently being prepared. In addition, the National Quantum Strategy is being developed and the National Artificial Intelligence Strategy of the Czech Republic 2030 is being finalised to replace the 2019 strategy. All these strategies should be linked to the National Semiconductor Strategy and should be complementary to each other.

Semiconductor technologies are also mentioned in the Digital Czech Republic - Digital Economy and Society (DES) concept, which aims to support the development of the Czech digital ecosystem through specific measures concerning research, development and application of new technologies (artificial intelligence, cloud computing, big data, blockchain, quantum technologies, etc.) in individual sectors of the economy, the corporate sphere, infrastructure and connectivity, and in legislative and institutional anchoring. The National Semiconductor Strategy directly implements measures to achieve some of the objectives set out in the chapter "Promoting connectivity and infrastructure for the digital economy and society".

In addition to the strategies being prepared and updated, the Export Strategy of the Czech Republic 2023-2033 was adopted in 2023. It focuses on diversifying exports, strengthening the ambition of Czech exporters and improving their position in supply chains. Furthermore, the strategy states that it is crucial to support new national champions capable of delivering complex solutions and high value-added products/services or in higher positions in value chains.

In connection with the preparation of the Economic Strategy of the Czech Republic, it is necessary to create suitable locations for manufacturing projects in the semiconductor sector (semiconductor component manufacturers and suppliers). From the point of view of competitiveness and the speed of settlement of new production capacities and other functions (science and research), a prepared location is essential. The State Investment and Development Company was set up to prepare strategic sites for this purpose.

Security

According to the Commission Recommendation of 3 October 2023, semiconductor technologies are among the areas of critical technologies for the economic security of the EU for further risk assessment with Member States, which is an important step towards strengthening economic security. This Recommendation follows on from the Joint Communication on the "European Economic Security Strategy". That Strategy identified four types of risks to economic security for subsequent assessment: risks to supply chain resilience, including energy security, risks to the physical and digital security of critical infrastructure, risks associated with technological security and technology leakage. For the priority risk assessment, which took place at the end of 2023, the EC identified: advanced semiconductors, artificial intelligence, quantum technologies and biotechnology.

Even the Czech Security Strategy 2023 sees it as essential that democratic states maintain a technological edge in areas that have the potential to change the distribution of geopolitical power and that can affect the defence capabilities of the EU and NATO. It is therefore important to have the strategies and tools to maintain a technological edge. Maintaining a technological edge cannot be achieved without the ability to effectively prevent the unwanted transfer of these technologies. For this reason, it is essential to make effective use of mechanisms to screen foreign investment, control exports or seek to increase the resilience of the academic sector to risky research collaboration.

Existing public support for the sector

Important Projects of Common European Interest (IPCEI) in the field of Microelectronics and Communication Technologies (IPCEI ME/CT) - the planned allocation for the research and development part is CZK 1.1 billion from the National Recovery Plan.

The 2024 investment incentive for ON Semiconductor Czech Republic - corporate income tax rebate and material support for technology acquisition totals CZK 567 million.

The 2023 investment incentive for Crytur - a corporate income tax rebate and material support for the acquisition of technology totals CZK 240 million.

In support of research, development and innovation,[2] was published between 2018 and 2022:

- Approximately CZK 500 million for large research infrastructures (CzechNanoLab and the Centre for Research and Development of Plasma and Nanotechnological Surface Treatments).

Approximately CZK 1 billion for projects supported by the Technology Agency of the Czech Republic, of which CZK 500 million for competence centre programmes (Progressive Detection Systems of Ionizing Radiation, Flexible Printed Microelectronics Using Organic and Hybrid Materials, Centre for Electron and Photon Optics, Platform of Advanced Microscopy and Spectroscopic Techniques for Nano and Microtechnologies and Electron Microscopy).

- The Grant Agency of the Czech Republic provided grants of CZK 230 million.
- The Ministry of Industry and Trade awarded grants of CZK 230 million.
- Ministry of the Interior in the amount of CZK 44 million.

[2] It should be noted here that not all of the means mentioned have an impact on the object of the strategy's focus. For example, in the large research infrastructures, issues that are not relevant tothe sector are also examined. Research by suppliers of equipment for the production of integrated circuits is also included in support for R&D activities. However, their products also find applications outside the semiconductor sector. The allocation of public funds for R&D is addressed in more detail in Annex 9 of the Strategy.

- The Ministry of Education, Youth and Sports provided grants of CZK 234 million, excluding support for large research infrastructures.

An analysis of public support for research, development and innovation is included in Annex 9.

ANALYTICAL PART

ANALYTICAL PART

This section describes the importance of the semiconductor components market to global supply chains, a description of the semiconductor components supply chain, an analysis of the size and growth of the semiconductor market, the demand for semiconductor components, the status of the individual value steps in the EU, the current state of the market in the Czech Republic, and an analysis and forecast of the talent required.

The importance of semiconductor components for global supply chains

Semiconductor components (microchips) are involved in global supply chains worth approximately $41 trillion (see Figure 1). Their involvement is most pronounced in the supply chain associated with the energy and materials sectors, where the value of this market enabled by semiconductor components is valued at $9.9 trillion. This is followed by the electronics sector at $5.3 trillion and the retail sector at $5.1 trillion. The mobility sector is in fourth place with an estimated size of $4.6 trillion.

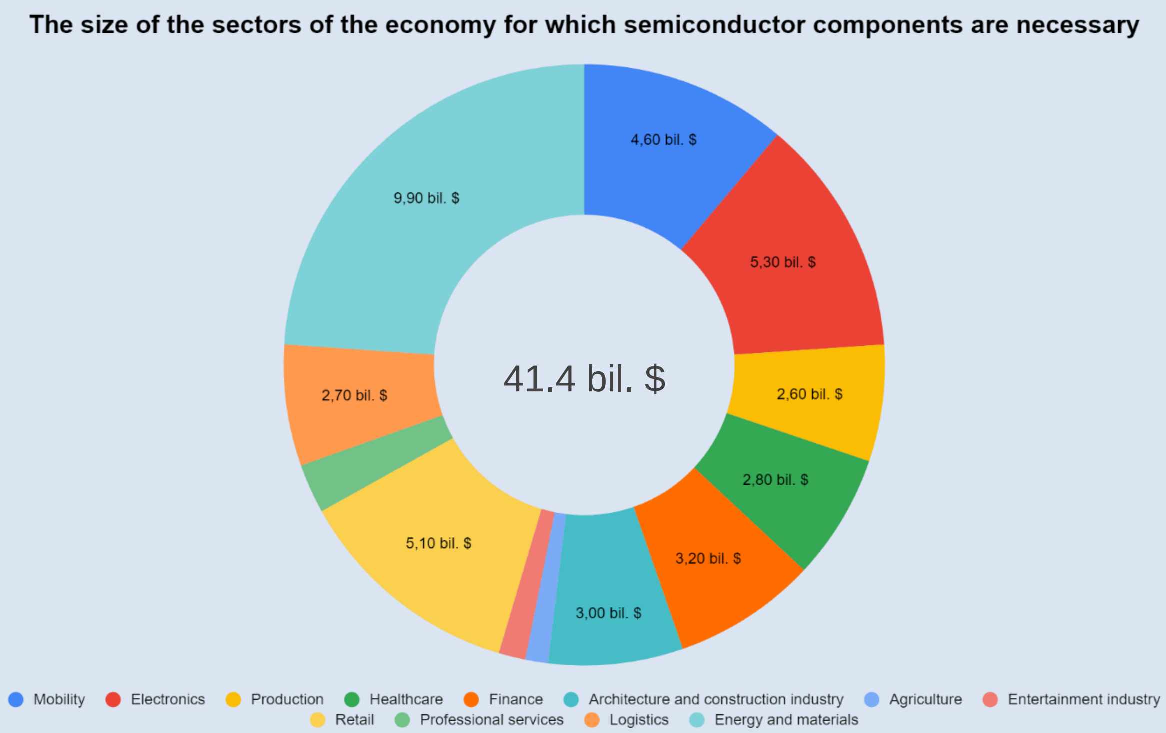


Figure 1: Integration of semiconductor components into global supply chains (SEMI.org, 2022)

Semiconductor components also have a significant presence in the supply chains of the financial sector ($3.2 trillion), construction ($3 trillion), healthcare ($2.8 trillion), and logistics ($2.7 trillion), the manufacturing sector excluding automotive ($2.6 trillion), professional services ($1.1 trillion), entertainment ($0.6 trillion) and agriculture ($0.5 trillion). Overall, there was a total of $41.4 trillion worth of involvement in chains. In comparison, the size of the world economy was estimated at $100.56 trillion in 2022 (World Bank, 2023). The involvement of semiconductor components in global supply chains in many sectors is expected to grow significantly further by 2030.

Structure of semiconductor components

Semiconductor components (Figure 2) are divided into two main categories. Analog components and digital (digital) components. Some sources also list components for power electronics as a separate category. These main categories can be further subdivided into integrated circuits, discrete semiconductor components, sensors and actuators, and optoelectronic components. Sensors and actuators are represented, for example, by image or temperature sensors. Sensors for X-ray and gamma imaging systems in medicine (CT, PET, SPECT, mammography, dentistry, etc.) are also important. Integrated circuits integrate multiple transistors (a semiconductor component with two P-N junctions) on a single chip. Discrete semiconductor components contain only one component (usually a diode, transistor or thyristor). Optoelectronic components include laser diodes and LEDs (Light-Emitting Diode). Integrated circuits are further divided into digital and analogue. Digital integrated circuits work with data encoded in binary (0,1). Analog integrated circuits work with a continuous signal.

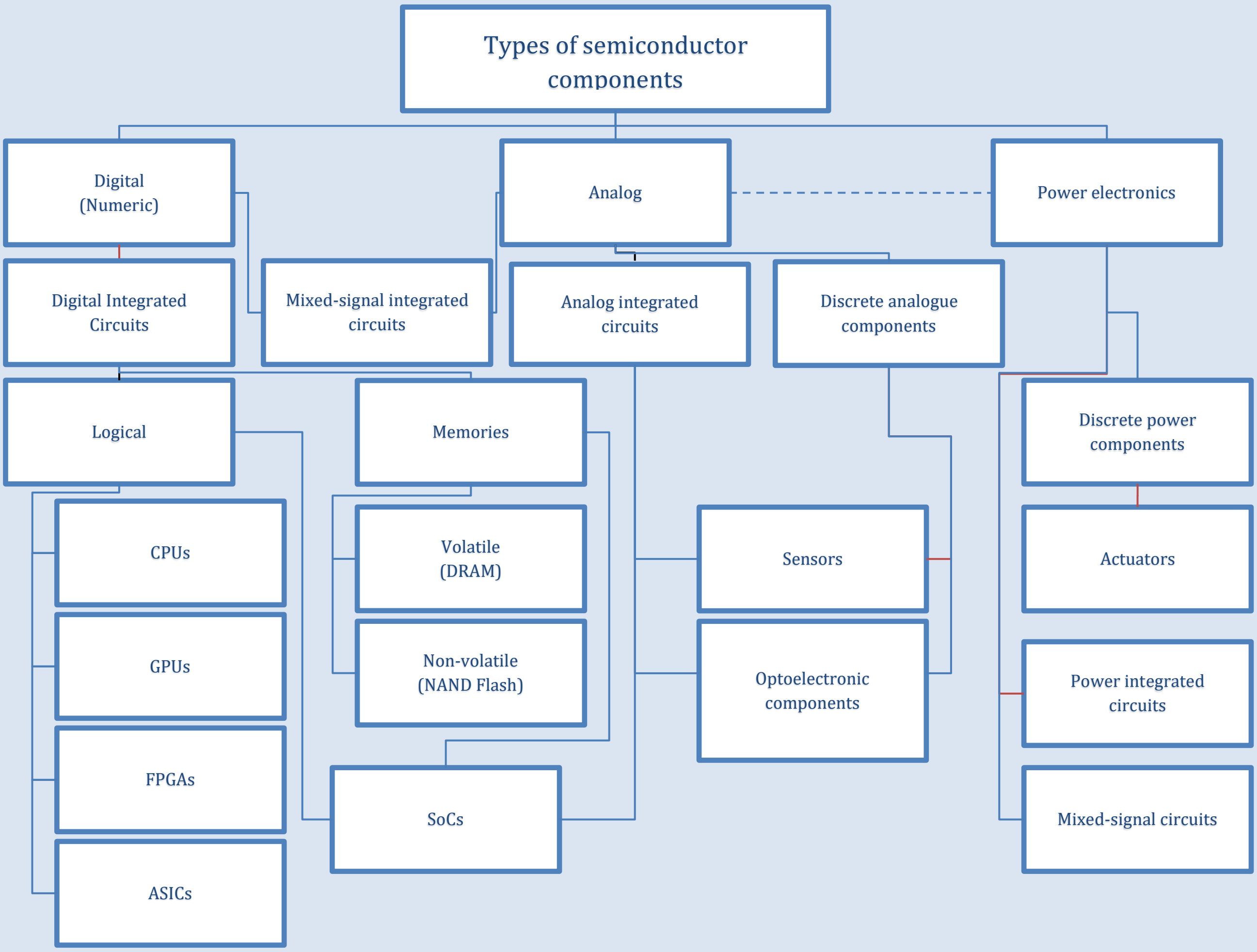


Figure 2: Main segments of the semiconductor supply chain and their share of the total value (Source: own)

Analog integrated circuits can be categorized into analogue circuits that process a signal (such as amplifiers) and antilog circuits that also operate with electrical current and voltage. Some classifications include power electronics among analogue circuits. In the case of power electronics, however, these are switching circuits that do not quite meet the definition of an analogue signal. Digital integrated circuits can be further classified into CPUs (Central Processing Units), GPUs (Graphic Processing Units, graphics accelerators), FPGAs (Field Programmable Gate Arrays) and ASICs (Application Specific Integrated Circuit). Memories can be further divided into volatile and non-volatile.

In Von Neumann's conception, the processor (CPU) is a general-purpose integrated circuit that processes a wide range of inputs. The graphics accelerator (GPU) has historically been used to render graphical output. However, with the advent of the need to process large volumes of data, the GPU began to be used for more general computation due to its architecture allowing parallel processing of inputs. For example, GPU features are used for training neural networks or scientific computing, especially simulation. Processors and graphics accelerators can also be classified in a separate category of micro integrated circuits. A field-programmable gate array (FPGA) is a unique type of integrated circuit that allows for reconfigurability. This allows the customer to change the structure of the logic blocks and thus change the characteristics of the chip to suit their needs. This type of integrated circuit is used in development or for devices with expected low sales where it is not worthwhile to design a dedicated circuit. An application-specific integrated circuit (ASIC) is a type of semiconductor component that is designed and manufactured for a specific application. This component does not allow for universal use and typically accelerates a specific algorithm or narrow set of algorithms. It is usually used in devices produced in large series.

Memory integrated circuits (memories) are divided into volatile, which cannot retain data after power is removed (DRAM, HBM), and non-volatile, which can retain data after power is removed (NAND flash).

An SoC (System on a Chip) is an integrated circuit that contains multiple components on a single chip. Typically, the CPU, GPU, AI accelerators, south bridge, north bridge and memory controllers, which are already integrated directly into the CPU, are integrated on a single chip. Gradually, volatile memories (DRAM or HBM) are also placed on one housing.

Mixed-signal circuits are semiconductor components that combine both antilog ICs and digital ICs.

Semiconductor supply chain

This chapter focuses on the analysis of the semiconductor supply chain. The overall composition of the supply chain is described and the individual actors are specified.

Components of the semiconductor supply chain

The semiconductor supply chain consists of material and noble gas suppliers, manufacturing equipment suppliers, EDA tools (Electronic design automation software) suppliers, fabless companies (integrated circuit designers), integrated circuit and power module manufacturers, as well as integrated circuit encapsulation and testing companies. However, the different steps of the supply chain can be provided by a single company. These companies are called IDM (Integrated device manufacturer).

In the case of material supplies, these include chemicals, copper, silicon, silicon carbide and other advanced semiconductor materials, specialty gases, precious metals and certain rare earth elements. For suppliers of production equipment, these include furnaces, lithography machines, epitaxy machines, suppliers of air and gas and liquid distribution equipment, inspection and testing machines or precision substrate processing machines. EDA tool providers focus on the development of tools for integrated circuit designers. EDA tool providers can also be added to providers of libraries and designs of sub-functionalities that developers can integrate into their own designs for a licensing fee (IP providers). IC manufacturers can be divided into substrate (wafer) manufacturers and companies involved in the actual manufacturing of ICs (front-end). The final step of manufacturing is cutting the wafer, bonding, wiring and encapsulating the chip in a package or power module (back-end). This step is also (not only) where chip testing takes place.

There are different types of companies on the market. IDM (Integrated Device Manufacturing) companies integrate several steps of the production chain. They both design and manufacture the chips. Another type of company is fabless companies, which specialise in the design of integrated circuits (chips). They then have these manufactured by custom manufacturers. These companies are called foundries and specialise in making integrated circuits (chips).

Market operators

As far as suppliers of production equipment are concerned, the Dutch ASML (ASML Holding) is the monopoly supplier of machines for EUV (Extreme Ultraviolet Lithography). ASML also produces DUV (Deep ultraviolet lithography) machines, which are the previous generation. DUV machines are also marketed by Japanese companies Nikon and Canon. German ZEISS and American Applied Materials play an important role in the production equipment market.

The main suppliers of EDA tools are the American companies Synopsys and Cadence Design Systems. Among the European companies we can mention Siemens EDA (Germany). However, its market share is not so significant.

Among the IP providers we can mention the originally British company ARM (today majority owned by the Japanese SoftBank), which supplies designs for computing units for mobile phones, but also for network elements, or industrial robots, consumer and white goods.

The largest fabless company by market capitalization at the beginning of 2024 is Nvidia (USA). The latter has seen a steep growth in market capitalisation due to the emergence of generative AI, for which it designs accelerators. Nvidia is also known for its graphics card designs. It also makes computing chips for automotive applications. Other major players are US companies Advanced Micro Devices (AMD, graphics cards, AI accelerators, CPUs) and Qualcomm (SoCs). Apple (A series, S series, M series...), Amazon (Graviton) and Google (Tensor) also design their own integrated circuits. Taiwanese companies MediaTek and Realtek should also be mentioned, but the United States dominates this sector.

Fundry services (integrated circuit manufacturing) are offered predominantly by Taiwanese companies. The largest of these is Taiwan Semiconductor Manufacturing Company, better known as TSMC (approx. 60% of the market). Taiwan's United Microelectronics Corporation (UMC, approx. 5%) is also well known. However, the number two company in the market is South Korea's Samsung (approx. 11% of the market) and the number three is the US-based GlobalFoundries with a market share of approx. 6% (Alsop, 2024). Mention should also be made of the Chinese company Semiconductor Manufacturing International Corporation (SMIC) and the US Intel is also interested in penetrating the foundry services market.

The most famous IDM is probably the American company Intel, which is known for its processors. But the memory market is dominated by South Korean companies Samsung and SK Hynix. The US Micron and Japan's Kioxia are also able to supply memory. Among the European companies, mention can be made of the French-Italian corporation STMicroelectronics, the Dutch NXP Semiconductors and the German Infineon Technologies. European companies do not usually focus on computing systems and tend to target their production on industrial applications.

The back-end has historically shifted to Southeast Asia due to labour intensity. Especially to countries like Malaysia and China. Representative companies operating in this sector are Amkor Technology, ASE Technology Holding or JCET Group.

The semiconductor supply chain and the EU's share of each value step

Within the semiconductor supply chain (see Figure 3), the European Commission (2022) has monitored the six main actors in the chain described above. The Commission concludes that the highest value added is in the manufacture of integrated circuits (34%), followed by the design of integrated circuits (30%), which is discussed in more detail in Annex 7, the provision of manufacturing equipment (17%), assembly, testing and encapsulation (10%), the provision of materials and silicon wafers with 7% and the lowest relative value added was identified in the provision of design tools and IP (3%).

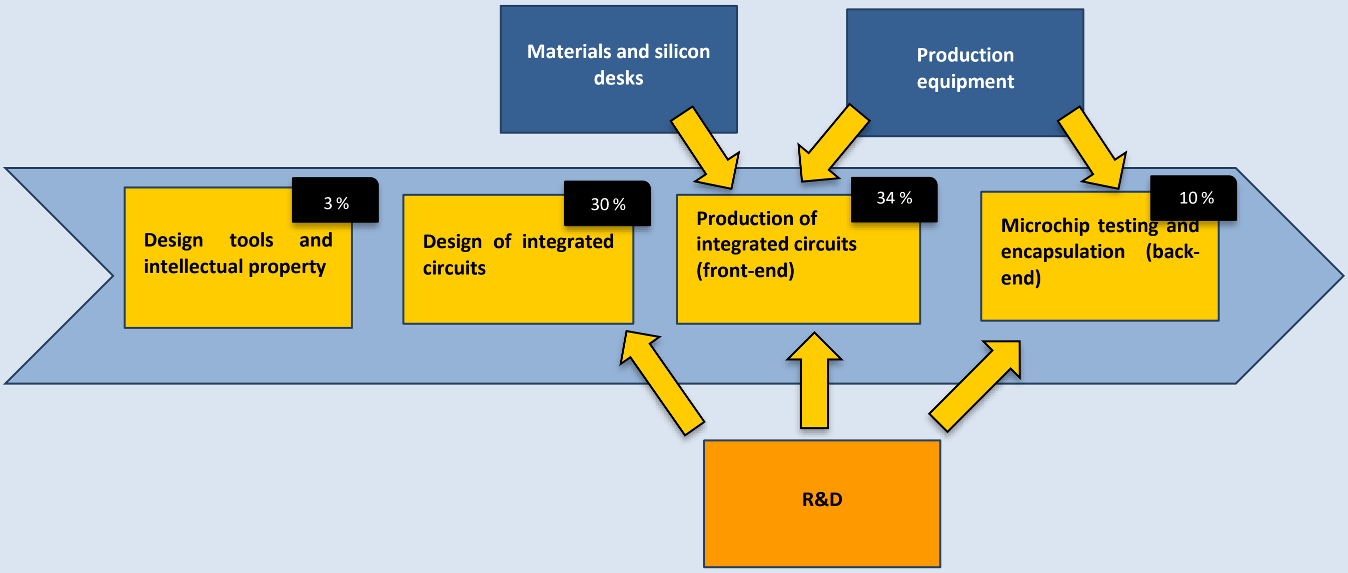


Figure 3: Main segments of the semiconductor supply chain and their share of the total value (Source: Staff Working Document European Chips Act, 2022)

In the analysis of market shares in the different parts of the supply chain (Figure 4 - yellow irregular hexagons), the European Union has the highest market share in the market for production equipment (21 %). The second highest market share is held in the market for materials and silicon wafers (14 %). The EU has a market share of a few percent in integrated circuit design (8 %), integrated circuit manufacturing (7 %), integrated circuit assembly, test and encapsulation (5 %) and only 2 % in the market for design tools and IP.

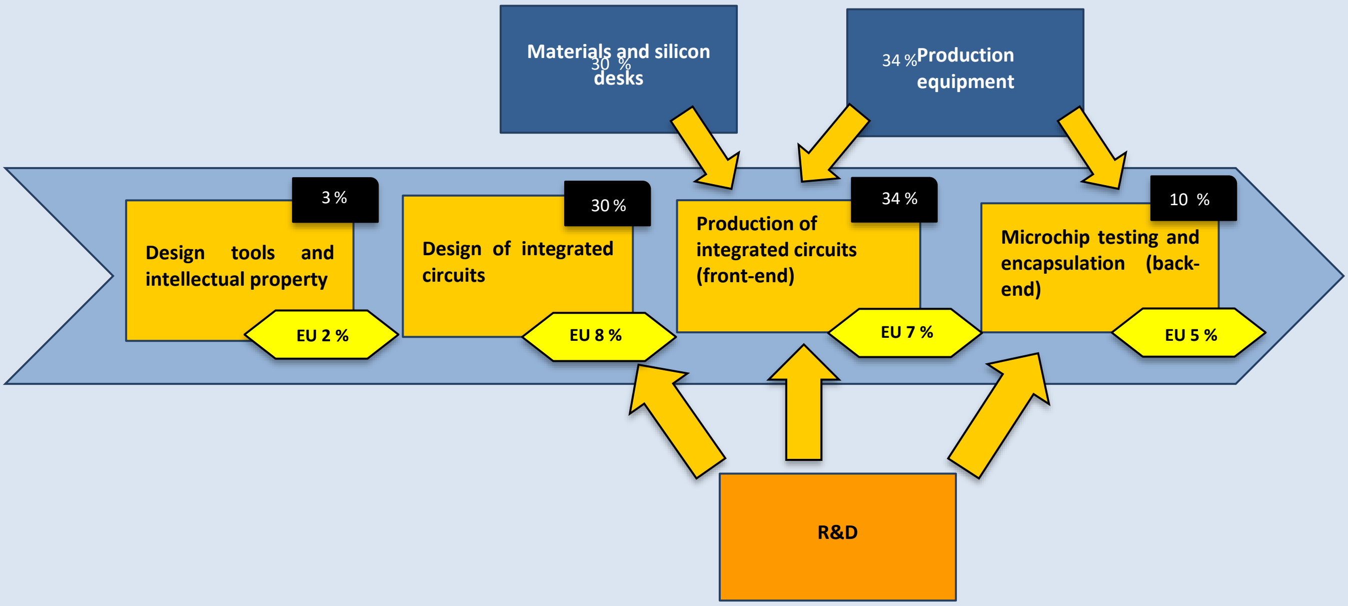


Figure 4: Main segments of the semiconductor supply chain and their share of the total value (Source: Staff Working Document European Chips Act, 2022)

Semiconductor components market size

The global semiconductor components market size is estimated at USD 607.4 billion in 2024. It is predicted to grow to US$ 980.8 billion in 2028. By 2030, the market value is expected to exceed one trillion US dollars. The market CAGR is estimated at 10,06 % between 2024 and 2028. Of the USD 607,4 billion, USD 515,00 billion in 2024 is accounted for by the integrated circuits market, USD 31,97 billion by the discrete semiconductor market, USD 42,10 billion by the optoelectronics market and USD 18,34 billion by the sensors and actuators market (see Table 1).

Table 1: Global semiconductor components market in USD billion (Data: Statista.com, processing: own)

Global market	**2024**	**2029**	**CAGR**
Integrated circuits	515,02	849,20	10,52 %
Of which:			
Analog integrated circuits	*77,90*	*125,90*	*10,08 %*
Logic integrated circuits	*195,90*	*363,00*	*13,13 %*
Memories	*164,70*	*260,60*	*9,61 %*
Micro Integrated Circuits	*76,52*	*99,70*	*5,43 %*
Discrete semiconductors	31,97	50,04	9,37 %
Optoelectronics	42,10	50,44	3,68 %
Sensors and actuators	18,34	31,06	11,11 %
Total	**607,43**	**980,74**	**10,06 %**

Within integrated circuits, the logic integrated circuits market accounts for $195.9 billion, memory $164.7 billion, analogue components $77.9 billion and micro integrated circuits $76.52 billion. The forecast used does not distinguish a separate category of power electronics, which is the focus of manufacturers in the Czech Republic. The power electronics market is estimated at $46.2 billion in 2023. In 2028, the market size is estimated at USD 61 billion. This is an average annual growth rate of 5.7% (MarketsandMarkets, 2023). Power electronics is discussed in more detail in Annex 6.

Market.us' longer-term forecast (2024) indicates that the global market will exceed US$1 trillion in 2030 and be worth US$1.3 trillion by 2032. This would be a compound average annual growth rate (CAGR) of 8.8%.

In Europe, the market is estimated to be worth EUR 56.37 billion (USD 60.79 billion) in 2024. In 2029, the industry is projected to reach EUR 87.38 billion (USD 93.24 billion) in Europe. The CAGR 2024 to 2029 is estimated at 9.16% (see Table 2).

Table 2: European semiconductor components market in billions of Euros (Data: Statista.com, processing: own)

European market (and EU)[3]	**2024 (EU)**	**2029 (EU)**	**CAGR (EU)**
Integrated circuits	42,64 (38,52)	67,53 (60,77)	9,63 % (9,55 %)
Of which:			
Analog integrated circuits	*10,90 (9,63)*	*17,25 (15,19)*	*9,62 % (9,54 %)*
Logic integrated circuits	*12,96 (11,62)*	*23,42 (20,94)*	*12,56 % (12,50 %)*
Memories	*10,45 (9,59)*	*16,35 (14,96)*	*9,37 % (9,30 %)*
Micro Integrated Circuits	*8,33 (7,68)*	*10,51 (9,68)*	*4,76 % (4,74 %)*
Discrete semiconductors	6,56 (5,90)	9,98 (8,97)	8,75 % (8,74 %)
Optoelectronics	3,88 (3,32)	4,44 (3,80)	2,73 % (2,74 %)
Sensors and actuators	3,29 (2,94)	5,43 (4,85)	10,54 % (10,53 %)
Total	**56,37 (50,68)**	**87,38 (78,39)**	**9,16 % (9,11 %)**

[3] Values in brackets are for EU member states only.

Analog ICs are estimated to generate revenues of €10.90 billion in 2024, growing to €17.25 billion in 2029 (CAGR 9.62%). For logic ICs, Europe is forecast to grow from €12.96 billion to €23.42 billion in 2029 (CAGR 12.57%). For memories, growth is forecast from €10.45 billion to €16.35 billion (CAGR 9.37%), micro-ICs from €8.33 billion to €10.51 billion (CAGR 4.76%).

The discrete semiconductor market in Europe is estimated to be €6.56 billion in 2024. In 2029, the market size is estimated at €9.98 billion. The CAGR for 2024 to 2029 is forecast at 8.75%. The Europe sensors and actuators market is estimated at EUR 3.29 billion in 2024, and is projected to grow at a CAGR of 10.54% by 2027.

The current market size within the European Union is estimated to be €50.68 billion in 2024. In 2029, the market is expected to reach a value of €78.39 billion. This represents an average annual market growth rate (CAGR) of 9.11%.

The highest average annual growth (12.50%) is projected for the logic IC market. The market for sensors and actuators follows with 10.53%. The third highest growth (9.54%) is forecast for the analogue IC market. On the other hand, the lowest average annual growth of only 2.74% is recorded for optoelectronics. MCUs are expected to grow at an average rate of 4.74% per annum and discrete semiconductors at 8.74% per annum.

Demand for semiconductor components in target markets

For the purpose of the analysis, the market has been divided into eight segments based on available data. These are: the smartphone segment, the server and data centre segment, the telecommunications segment, the industrial electronics segment, the automotive segment, the consumer electronics segment, the personal computer segment and the others, which include, for example, the healthcare or defence segment.

Data from 2022 shows that personal computers (PCs, laptops) occupied about 19.7% of the target market, smartphones 32.8%, servers and data centres 17.8%, telecommunications 3.5% (network elements, but also telecommunications satellites) and consumer electronics 7.7% (e.g., smart watches, game consoles, etc.), industrial electronics (non-automotive) holds an 8.4% share, the automotive segment alone has a 7.7% share and other sectors 2.4% (see Figure 5).

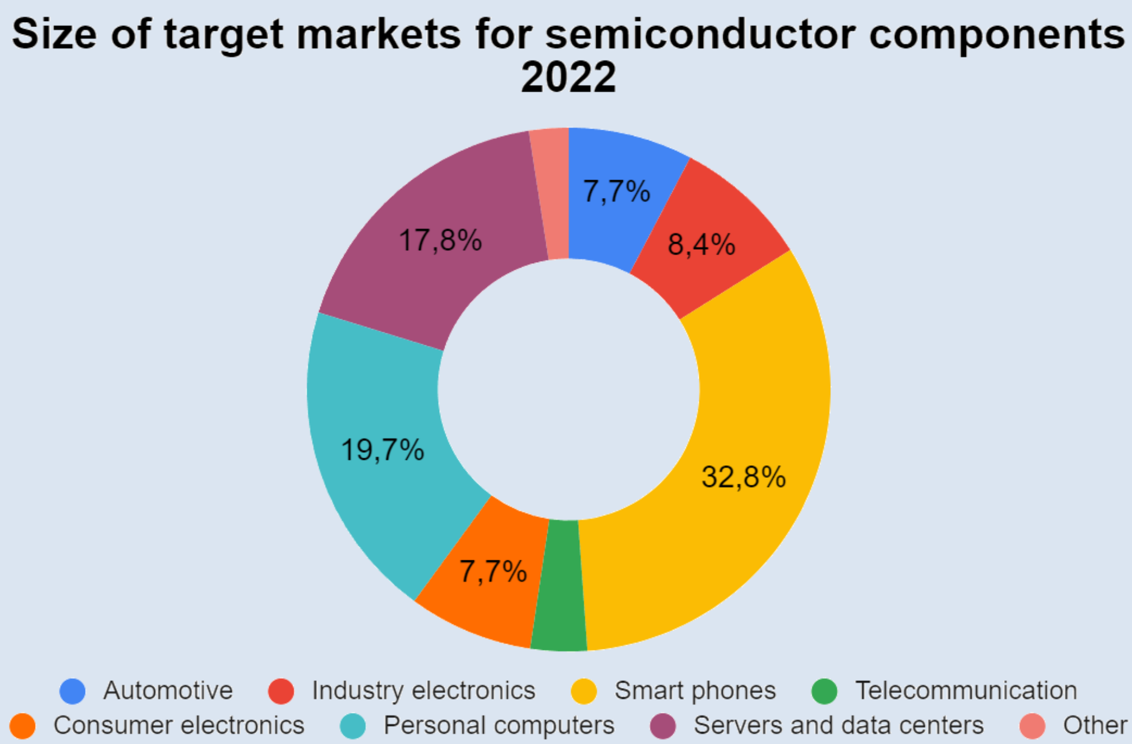


Figure 5: Target Market Size for Semiconductor Components 2022 (Data: Yule Intelligence, 2023)

To forecast the growth of the target markets, the strategy developers only have an older forecast from 2021 (Figure 6). Based on 2020 data and other facts, it predicts 2025 and 2030. According to this forecast, target markets will climb from $467 billion in 2020 to $693 billion in 2025 and $940 billion in 2030. This is an increase of approximately 101% over 10 years. The automotive sector is expected to grow the most with a 236% increase, followed by the server and data centre sector with a 146% increase. This is followed by the industrial sector with an increase of 138%. In contrast, below-average growth is forecast for the personal computer market. The telecommunications sector (66%) and the smartphone sector (81%) are also expected to grow more slowly.

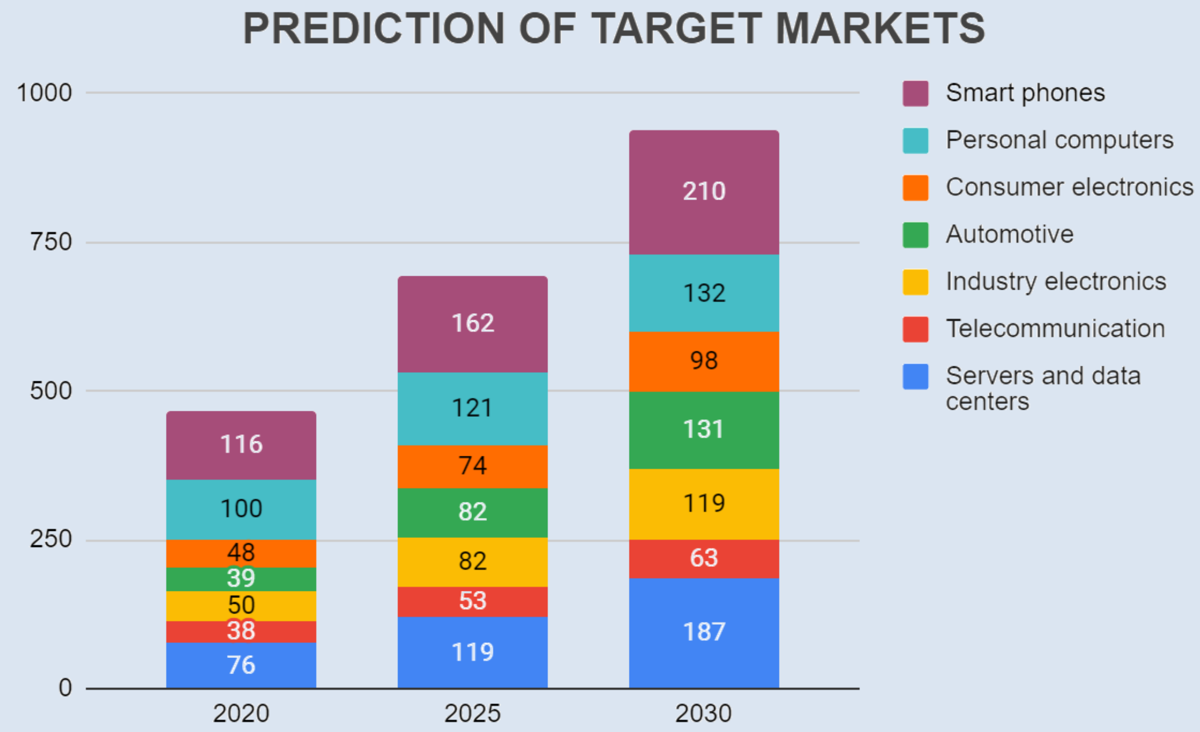


Figure 6: Current status and forecast demand for semiconductor components in target markets in USD billion (Data: Statista.com and ASML, 2021)

Looking at the 2022 data (Figure 7) across two dimensions (target market and component type), the smartphone segment was responsible for the highest demand overall ($188 billion). The smartphone segment was also responsible for the highest demand for memory chips ($49 billion), optoelectronics and sensors ($26 billion), as well as analogue components and power electronics ($64 billion). The highest demand for logic chips was then in the personal computer segment (USD 66 billion), followed by servers and data centres (USD 52 billion) and only the third segment demanding logic chips was smartphones (USD 49 billion). The situation was similar for memory chips. The servers and data centres segment were responsible for the second highest demand for memory chips (USD 42 billion), followed by personal computers (USD 31 billion). The automotive and industrial electronics segments, which are crucial for Europe, together demanded memory chips worth USD 11 billion, logic chips worth USD 24 billion, power electronics and analogue components worth USD 26 billion and optoelectronic components and sensors worth USD 26 billion. The other segment (healthcare, defence, etc.) demanded components worth a total of USD 14 billion.

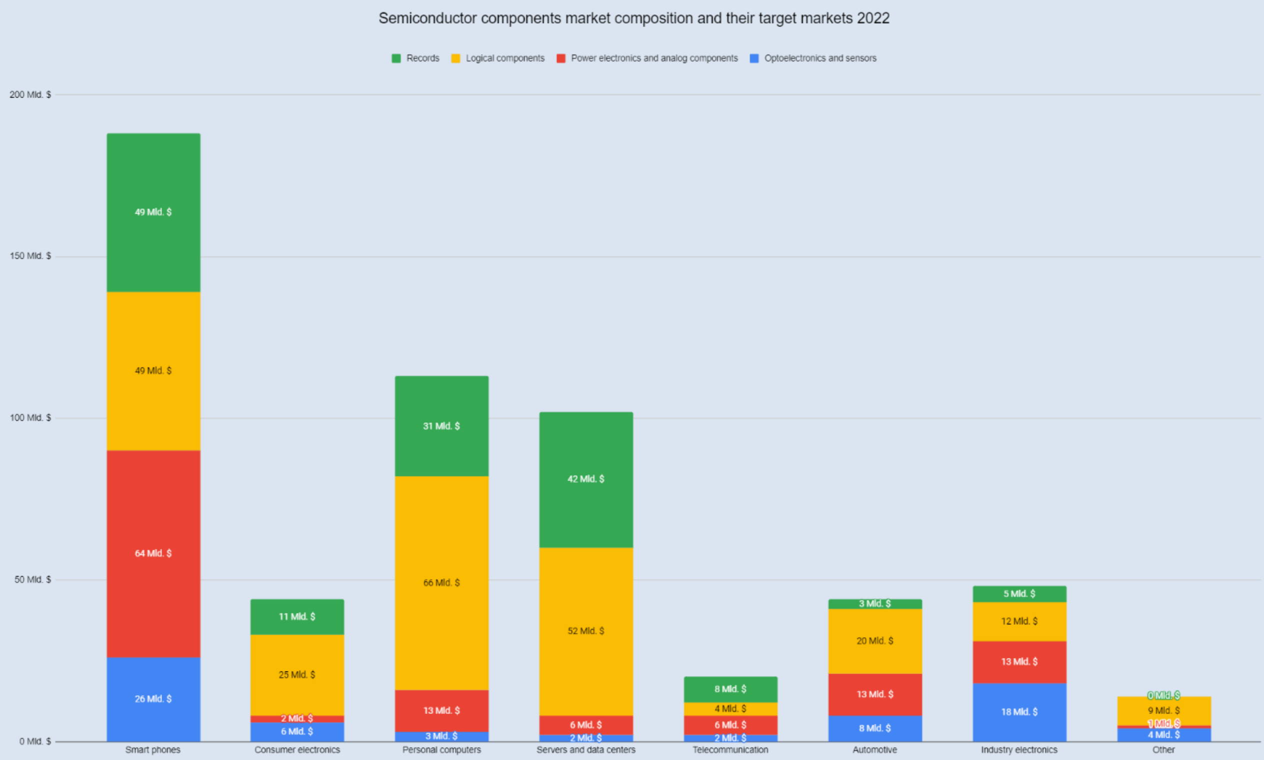


Figure 7: Current status and forecast demand for semiconductor components in target markets in USD billion (Data: Statista.com and ASML, 2021)

Demand for microprocessors made with sub-6nm manufacturing technology is forecast to grow significantly by 2027. Conversely, demand for logic integrated circuits made with manufacturing technologies above 6 nm is forecast to decline (IBS, 2022). There is currently no factory in the European Union that can produce chips with sub-14 nm manufacturing technology.

Current position of the market in the Czech Republic, its structure and capacity

The size of the Czech market (Table 3) is estimated at approximately EUR 1.97 billion (USD 2.13 billion and CZK 49 billion) in 2024. The market in the Czech Republic is projected to grow to approximately EUR 2.97 billion (USD 3.17 billion and CZK 75 billion). This represents an average annual growth of around 8.51 %.

Table 3: Czech market for semiconductor components in EUR million (Data: Statista.com, processing: own)

Czech market	**2024**	**2029**	**CAGR**
Integrated circuits	1 732,2	2 616,5	8,53 %
Of which:			
Analog integrated circuits	*163,90*	*262,7*	*9,89 %*
Logic integrated circuits	*188,3*	*343,8*	*12,80 %*
Memories	*830,00*	*1 310,00*	*9,56 %*
Micro Integrated Circuits	*550,00*	*700,00*	*4,94 %*
Discrete semiconductors	*124,00*	*189,60*	*8,86 %*
Optoelectronics	*53,17*	*61,67*	*3,01 %*
Sensors and actuators	*61,87*	*103,00*	*10,73 %*
Total	**1 971,24**	**2 970,77**	**8,51 %**

The largest sales, €830 million, are recorded for memories, followed by micro integrated circuits (mainly microprocessors and microcontrollers) with €550 million, logic integrated circuits (€188.3 million), analogue integrated circuits (€163.9 million) and discrete semiconductors (€124.0 million). The highest average annual CAGR is forecast for logic ICs (12.80%) and analogue ICs (9.89%) until 2029.

In 2029, the highest demand is still expected for memories (€1,310 million), with average annual market growth estimated at 9.56%. The second highest demand is projected for micro integrated circuits (€700 million), followed by logic integrated circuits (€343.8 million), analogue integrated circuits ($262.7 million). Also close to the €200 million mark is the projected demand for discrete semiconductors (€189.6 billion).

Considering the production capacity of the Czech Republic (see the following chapter for details), the production in the Czech Republic was able to satisfy about 16%. Given the production parameters in the Czech Republic, this satisfaction will be higher for analogue integrated circuits and discrete semiconductors (generally power electronics). In contrast, memories, logic integrated circuits and micro integrated circuits are not produced in the Czech Republic. However, for micro integrated circuits and logic integrated circuits, the Czech industry is capable of designing them.

Semiconductor sector in the Czech Republic

This chapter describes the current state of the semiconductor sector in the Czech Republic, including the educational system. A full list of entities as of the date of adoption of the strategy is included in Annex 2.

General

On the basis of analyses of the financial statements, it was found that the integrated circuit design sector in the Czech Republic employed about 1,000 people in 2021 and had a turnover of about CZK 1,360 million. The integrated circuit and discrete semiconductor component manufacturing sector employed approximately 2 000 people and had a turnover of approximately CZK 7.3 billion. (Data from the Czech Statistical Office indicate a production in the Czech Republic for 2023 of approximately CZK 7.9 billion.) Suppliers to the semiconductor sector have sales of approximately CZK 25 billion and employ an estimated 3,000 people. Overall, the sector directly employs about 6 000 people in the Czech Republic and generates revenues of CZK 33.66 billion.

The Czech Republic's share of the EU market share is estimated at 0.7%. This is less than would be consistent with the strength of the economy (the Czech economy accounts for 1.8% of the total EU economy measured on a GDP basis).

Production

There are currently (beginning of 2024) two semiconductor component manufacturing plants in the Czech Republic owned by foreign companies. The smaller plant is in Prague and is dedicated mainly to the production of discrete semiconductor components for use in applications requiring power electronics. The second production plant is located in the Zain region. The latter is dedicated to the production of analogue integrated circuits, with a substantial part of its production and especially its upcoming massive development plan involving modules and components for power electronics (mainly SiC). In the Czech Republic there is also potential for spin-offs from academia involved in the production of power modules.

Integrated circuit design

Both branches of foreign companies and companies owned by domestic capital are located in the Czech Republic. In the field of integrated circuit design, companies operating in the Czech Republic can design all types of integrated circuits (analogue, mixed and digital). The main centres of integrated circuit design are Prague, Brno and Rožnov pod Radhoštěm.

Software solutions

The overall software ecosystem needed for microcontroller users, including configuration tools, is being developed in the Czech Republic. Furthermore, tools for front-end analysis of integrated circuit manufacturing using AI systems or Electronic Design Automation (EDA) Tools are being developed.

Semiconductor component manufacturing equipment and infrastructure suppliers

The entities operating in the Czech Republic focus on the production of furnaces for thin film deposition, equipment for the distribution of liquids and gases, the production of temperature switchboards or the design and implementation of clean rooms.

Suppliers of process diagnostic equipment

Process diagnostic equipment in the Czech Republic is represented by manufacturers of electron microscopes. Electron microscopy in the semiconductor industry comprises a group of instruments using charged particles (electrons, ions, ion clusters) for structural, metrological and material analysis across the life cycle of semiconductor chips. Electron microscopy is a critical technology in this respect.

Research and development and innovation[4]

Research activities are carried out mainly at the CTU in Prague, Brno University of Technology and ZČU in Pilsen. The Academy of Sciences of the Czech Republic and Charles University are also active. Research is focused on the production of semiconductor substrates, epitaxial and other thin film deposition technologies, design of semiconductor components for very high voltages, analogue and mixed integrated circuits, radiation-hardened microelectronics and radiation detectors (research on radiation-hardened ionising radiation detectors and detectors for high-energy physics, research on sensors for X-ray imaging in medical applications), digital integrated circuits, casing and contacting of integrated and power circuits, spin electronics and lithography research. The Czech Republic also has very good competences in substrates, copper printing (TPC), contacting and diagnostics/defectoscopy and testing.

Current state and capacity of the education system

Comprehensive education in the field of microelectronics is currently provided only by the Institute of Microelectronics of the FEC of the CTU and the Department of Microelectronics of the FEL CTU. Both institutes are similar in size (number of employees and PhD students). They offer both bachelor (FEKT BUT - Microelectronics and Technology Programme, FEL CTU - Electronics and Communication Programme and Open Electronic Systems Programme) and master (FEKT BUT - Microelectronics Programme, Microelectronics Programme, FEL CTU - Electronics and Communication Programme in both Czech and English versions) study programmes closely focused on electronics, integrated circuit design, semiconductor technologies and related areas. Approximately 100 bachelor and about 70 master students graduate annually from the above-mentioned programmes at these two institutes. It should be stressed that not all of these graduates want to go into chip design or semiconductor technology. They are estimated to be about one third of this number. The rest find employment in companies focused on "classical" electronics, microcontroller programming or electronic device design. In terms of personnel and capacity, both institutions are able to "generate" about half as many graduates.

Other faculties that at least partially address the issue of chips, or their use in various applications, are FIT BUT and the already mentioned FJFI and FIT CTU. Here it is mainly the bachelor study programmes Information Technology (FIT BUT), where within selected specializations it is possible to deal with the issue of microprocessors, their programming and applications, at FIT CTU then Computer Engineering - FIT CTU

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[4] Annexes 2 and 9 deal with the issue in more detail.

(incl. Of course, there are further Master's programmes in Cyber Security, Embedded Systems, Intelligent Devices at FIT CTU and Design and Programming of Embedded Systems - FIT CTU (incl. English version). The numbers of graduates of these programs who continue to focus on some form of chip design or application after graduation are in the low teens, more like units. The Faculty of Mathematics and Physics at Charles University offers education in solids with a focus on semiconductors.

In the field of semiconductor technologies, the FSI or CEITEC BUT in Brno teaches in the Master's programme in Physical Engineering and Nanotechnology, where there are about 50 students per year and about half of them finish their studies. CEITEC shares its CMOS prototyping line with the international community, which is unique in the opportunity to personally verify the individual steps from chip design to finalisation. It is the only such equipped workplace not only in the Czech Republic.

Further increase in the number of graduates is mainly due to insufficient funding of higher education by the state budget, and the resulting insufficient staff capacity in education, which is also fragmented among a large number of activities (mainly research and development, teaching and administration). According to the universities' representations, universities are short of about 11 billion crowns. The Czech Republic's expenditure on higher education relative to gross domestic product (GDP) is slightly below the average of the European Union and OECD countries. In 2020, the average of such expenditure in OECD countries was 1.17%, while in the Czech Republic it was 1.09%. In 2020, 33% of the Czech population aged 25-34 had successfully completed tertiary education, compared to the EU27 average of 40.5% in the same year.

In the context of the National Semiconductor Strategy, it is necessary to formulate requirements for education in the field of semiconductors also for other faculties, especially for electrical engineering faculties, which have not dealt with the issue at all or only marginally. Another important step is also the staffing of experts at universities, which will be necessary not only to increase the necessary educational and research capacity, but also to ensure the generational renewal of academic staff. However, this must go hand in hand with sufficient funding, as it is very difficult to attract quality PhD students with the prospect of an academic career in a context of insufficient financial remuneration and high demand from industry. For comparison, the projected shortage of workers in this area in the EU in 2030, if the target (EU market share of 20%) is met, is shown in Figure 8.

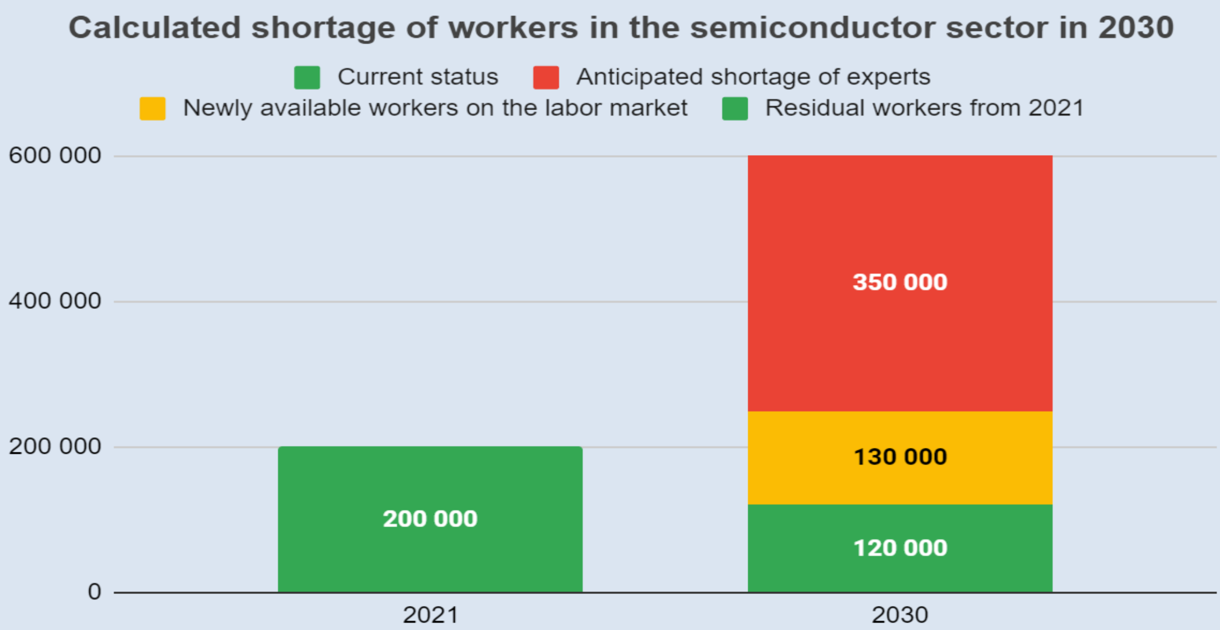


Figure 8: Projected worker shortages in 2030 if the EU market share of 20% is met (Data: European Commission, 2023)

Based on the projected developments, it is estimated that there will be a shortage of 350,000 professionals in the EU labour market.

According to METIS analysis (2021), the skills in demand are mainly in the areas of machine learning and artificial intelligence, data analytics, system design and system architecture (SoC -System-On-Chip-, SiP -System-In-Package-, SoP -System-On-Package-, complex ASIC) and analogue or mix-signal integrated circuit design.

In the future, we can also expect a demand for digital integrated circuit designers.

Target market analysis

For further analysis, five **sectors** and three **key technologies** that can benefit from the development of integrated circuit design in the Czech Republic were selected based on the National RIS3 strategy:

Industries

1. ***Automotive**, in particular electric vehicles (Transport for the 21st century thematic area);*
2. ***Railways and rolling stock** (Transport for the 21st century thematic area);*
3. ***Aerospace**, in particular the space sector (Transport for the 21st century thematic area);*
4. ***Energy** (Advanced machines/technologies for globally competitive industry);*
5. ***Electronics and Electrical Engineering** (thematic area Digital Technologies and Electrical Engineering).*

Key technologies

1. ***Cybersecurity** (thematic area Digital Technologies and Electrical Engineering, key technology Digital Security and Connectivity);*
2. ***Artificial Intelligence** (thematic area Digital Technologies and Electrical Engineering, key technology Artificial Intelligence);*
3. ***Photonics and Micro/Nanoelectronics** (thematic area Digital Technologies and Electrical Engineering, key technology Photonics and Micro/Nanoelectronics).*

Apart from these sectors mentioned in the National RIS3 strategy, the medical sector is also interesting, which is characterised by an emphasis on lower volume, qualitatively advanced components with very high added value.

Application sector

Given the current structure of the economy, the most important application sector in the Czech Republic in terms of volume is clearly the transport sector, with the automotive sector having the majority share. The Czech Republic has significant national application competence and interesting market potential in traction (or railway systems - here the leader is Plzeň). A large market is opening up especially for high-voltage semiconductor systems in the energy sector.

In the world, with the development of generative artificial intelligence, the market for AI accelerators is particularly important. The cybersecurity market is also interesting.

1. Automotive

In Europe, the most important application sector in terms of volume is clearly transport, specifically automotive. The Czech Republic is already quite strong in this target market through the activities of onsemi (ON Semiconductor) (see Annex 1) and NXP (NXP Semiconductors) or Hitachi Energy. Onsemi is involved in the design and manufacture of semiconductor chips for power electronics (Power Electronics). These chips, for example, change voltage, convert AC to DC or take care of power management. The company has even already established cooperation with European car manufacturers and is a leader in the development of chips on silicon carbide substrates. Hitachi Energy manufactures welding diodes, which are a key component in spot welding equipment for aluminium or steel car bodies. With a market share of over 50%, it is the world leader in welding diodes (Total Available Market = USD 25 million).

In cars, various older microcontrollers are also needed for elementary functions (e.g., wiping windows). But these are low-end products produced on outdated manufacturing technologies, for which there may be acute shortages (shortages caused by, for example, production failures during the covid-19 pandemic), but in the long term their production in Europe is not very profitable and their research and development would no longer bring high added value. Automotive companies are moving towards more modern types of microcontrollers. In addition, there is a growing segment of chips with embedded AI, for example to evaluate images from cameras and other sensors for autonomous driving, or chips that will increase the cybersecurity of vehicles. A major trend is IoV (Internet of Vehicles), for which chips for wireless communication must also be deployed in cars. The market is quite large. In Europe, the automotive sector accounts for 37% of demand for all chips (European Commission, 2022).

As one of the world leaders in automotive semiconductors, NXP offers a broad portfolio of microprocessors and microcontrollers, including advanced solutions for vehicle sensor systems and driver assistance systems. These include vehicle environment perception sensors and data fusion systems for intelligent data analysis. NXP's activities in the Czech Republic are primarily focused on research and development of embedded software solutions, which are nowadays crucial for automotive manufacturers to remain competitive.

Embedded software development is of utmost importance to the automotive industry. It plays a key role in enabling advanced features, improving safety and enhancing overall vehicle performance. As vehicles become increasingly software-defined, the ability to develop robust, efficient and secure embedded software is essential for OEMs to remain competitive in the market. Embedded software development ensures seamless integration of various vehicle systems, including powertrain, infotainment, driver assistance and connectivity, enabling a friendly driving experience. A key trend for automotive SW has been the SW Defined Vehicle (SDV) concept, which brings technologies previously known and used from industrial plants, offices and data centres (e.g., Ethernet-based communications, Cloud solutions, cyber security and more) to the automotive industry. The development of chips for the automotive sector is thus inextricably linked to the development of advanced software. In addition, it enables continuous innovation, adaptability to emerging technologies and the ability to meet evolving customer requirements.

Carmakers are trying to catch up with the lead created by Tesla, which has started designing AI-enabled processors and chips on its own to stop being dependent on Nvidia. Tesla is being overtaken by BYD, and companies like Xiaomi are also getting involved, and are expected to hold at least ⅓ of the global market by 2030. Cars of this provenance are characterized by a high involvement of high-end performance chips in the extensive infotainment of the car, unlike European cars where this part is less equipped. Coda sip, together with a number of companies from the automotive sector, is involved in projects where the aim is to design new complex chips containing innovative very complex microprocessors, capable of running very complex software in real time, such as anti-collision systems, infotainment, etc. with the need for fast processing of large amounts of data in the cloud. Given the new massive investment in new software development (for the new era of the Internet of Cars), the drive is to move away from Arm's closed solution and move rapidly to the **open RISC-V processor standard**. Since one such chip contains up to 100 different processors, the aim is to significantly shorten the development cycle using design automation tools (EDA), and the Czech Republic has essential know-how in this area as well.

Overall, the global passenger car market is estimated to reach $2,090 billion in 2027 (up from $1,989 billion in 2024). It is expected to achieve a compound annual average growth rate (CAGR) of 1.25%. SUVs are expected to be the largest segment with a value of $842.6 billion. Overall, 75.16 million units of passenger cars are projected to be sold in 2028 (Statista.com, 2024b). For EVs, the market is projected to grow at an average rate of 12.66% from $422.8 billion in 2024 to $681.2 billion in 2028. Overall, 13.47 million units of EVs are projected to be sold globally in 2028 (Statista.com, 2024c). Plug-in hybrids are projected to grow at an average rate of 2.97% from $200.6 billion in 2024 to $225.5 billion in 2028. 3.6 million plug-in hybrids are projected to be sold globally in 2028 (Statista.com, 2024d).

2. Railway and rolling stock

The Czech Republic has a significant national application competence in traction (or railway systems). The Czech Republic is already quite strong in this target market through the activities of Hitachi Energy (see Annex 1). This company is involved in the design and manufacture of discrete semiconductor components for power electronics (Power Electronics). These chips, for example, process voltage, convert AC to DC or take care of power management and power quality. In the context of securing the rail network but also the rolling stock itself, it is possible to extend national competence in this area by supplying chips that enhance cyber security. Chips for wireless communication are also an option. However, this market is smaller compared to the automotive market. The industry as a whole account for 25% of the demand for chips in Europe (European Commission, 2022). R&D competences and capacities for these activities are mostly concentrated at ZČU in significant cooperation with the ŠKODA GROUP.

3. Aerospace industry

The space sector is another industry in the Czech Republic where competencies in the semiconductor value chain can be applied. The Czech Republic is home to EUSPA and is also a member of the European Space Agency (ESA). Over the last 15 years, the Czech Republic has succeeded in building up its space industry and integrating it into international supply chains. We currently have over 150 established companies, start-ups and academic institutions active and successful in space activities, and this number continues to grow rapidly. Czech companies and research institutions are already involved in more than 600 high-tech space projects. The Solar Orbiter (Sun) or the Juice (Jupiter) probe are just a few examples. In the Czech Republic, teams at the Faculty of Nuclear and Physical Engineering of the Czech Technical University in Prague are developing chips for use in space and have completed samples of chips for satellites. Two institutes at the Faculty of Electrical Engineering and Communication Technologies of Brno University of Technology have many years of experience in designing chips and complex electronic systems for the space and aerospace industry, for example, next-generation meteosatellites or lunar landers. These institutes are qualified suppliers of these systems for ESA. The related technologies, especially the necessary electronic subsystems, are mainly handled by ZČU. The Faculty of Mathematics and Physics of Charles University is also active in the sector.

The main industrial players in this area include ÚJP Praha, members of the Brno Space Cluster and many others.

The aerospace sector is already bigger. However, the problem is the long product life cycle, certification requirements and the oligopolistic market structure with two major transport aircraft manufacturers. However, there is also room for sales of safety chips.

4. Energy

A large market is opening up, especially for high-voltage semiconductor systems, in the energy sector. The energy transformation is crucial for the future of Czech industry. As a result of the Russian-induced military conflict on the territory of the sovereign state of Ukraine, which violates international law, it has become necessary to work on strengthening European energy autonomy. This entails moving away from fossil fuels, of which the Russian Federation was the dominant supplier. Today's energy system has to cope with an energy mix that includes both stationary large sources and renewable sources. But these have different characteristics of their output. Photovoltaic panels, for example, generate direct current, which must be converted to alternating current for the needs of the power grid. In addition, various variants of power semiconductor converters are needed, currently mainly using IGBT, SiC or GaN technologies, with diodes and thyristors that modify the current and voltage characteristics (Power Electronics). In the Czech Republic, Hitachi Energy is active in discrete semiconductor components and modules, and onsemi could also supply chips to power grids if it targets this sector with one of its product lines. Overall, this area is already covered in the Czech Republic. R&D competences and capacities for these activities are mostly concentrated at ZČU.

The energy market is estimated to grow by an average of 4.84% (Statista.com, 2024e).

5. Electronics and electrical engineering together with the digital economy

These two application sectors cannot be strictly separated; they already play an important role in ensuring the Czech Republic's competitiveness in the world. Semiconductors and integrated circuits are currently playing a key role in the world of electronics. Our society is practically dependent on consumer and computer electronics. This is also linked to the rise of all modern computer and communication technologies, such as 5G technologies, which are highly dependent on advanced chips. The trend is also that with rising living standards, individual households in other parts of the world are also adopting modern lifestyles where chips are indispensable for a comfortable life. Their development will be crucial for the sustainability of the Czech industry.

The national RIS3 strategy mentions in particular the application of semiconductor technologies in HPC systems (supercomputers), cybersecurity, data-driven economy, electronic devices and instrumentation systems with high added value, as well as in electrical engineering and digital technologies for Industry 4.0. Semiconductor technologies will also support the use of artificial intelligence and quantum technologies. Combined with traditional skills in engineering, completely new application possibilities are opening up. For example, new areas of micro and nano mechanics or the development of new materials.

Key technologies

This is a technology with high growth potential and a need for semiconductor components for its development.

1. Cyber security

The Czech Republic has long been strong in this area. Both as a creator of antivirus software and in network traffic analysis, for example. We can mention Avast Software, AVG Technologies, Cognitive Security and Flowmon. In the field of research, for example, the activities of the CZ.NIC association and its Turris routers or the activities of the CyberSecurity Hub, established as a registered institute of the CTU, CTU and MU. Even in the field of integrated circuit design, the company Tropic Square is involved in the design of the Secure Element (a chip that prevents unauthorised access) and has already verified its design on UMC's 55 nm process. Codasip designs technology and chips for post-quantum cryptography. For the automotive sector, a technical security solution is essential, which is why companies are moving to the open RISC-V standard, which is much more suitable than existing closed solutions.

Quantum key distribution and True Random Key generation are also part of the issue, which is dealt with by several entities in the Czech Republic.

The cybersecurity market is projected to grow at an average rate of 10.56% annually from $92.91 billion in 2024 to $273.6 billion in 2028 (Statista.com, 2024f).

2. Artificial Intelligence

In the field of artificial intelligence in general, the Faculty of Electrical Engineering at CTU is particularly strong, on the basis of which the company Cognitive Security was founded, which used behavioural analysis and artificial intelligence based on it to detect cyber attacks. This company was bought by the American technology company Cisco in 2013. Cisco then also established a collaboration with the faculty itself. This collaboration continues to this day. Experts from the Faculty of Electrical Engineering and Communication Technology and the Faculty of Information Technology at Brno University of Technology also have long experience in this field. Significant competences in the field of artificial intelligence are also available at ZČU, specifically at the Faculty of Applied Sciences and the Faculty of Electrical Engineering.

Computational power is important for the development of this field, both for learning neural networks and their implementation. Therefore, special integrated circuits designed to accelerate the computations needed to create neural networks have begun to emerge around the world. However, the development of these chips is not yet underway in the Czech Republic. However, this is a potentially interesting application sector in which there is already a certain supply of accelerators and special circuits, so it will be more challenging to promote in this area.

The AI systems market is expected to grow from $305.9 billion to $738.8 billion in 2030. The average annual growth is estimated at 15.83% (Statista.com, 2024g).

AI systems also have the potential to streamline the development and production of integrated circuits. A separate annex is devoted to this issue.

3. Photonics and micro/nanoelectronics

The wide application of this key technology is related to the fact that electronic and optoelectronic systems are part of all modern manufacturing technologies. The results of R&D&I focused on photonics and micro/nanoelectronics will be applied in the field of electronics and optoelectronics, respectively optical communications and digital technologies. The potential for application is particularly in optical sensors, optical sources, light guides and optical fibres.

Opportunities of the Czech semiconductor chain

The Czech semiconductor chain is particularly strong in the supply of machinery and equipment for the production of integrated circuits. The Czech Republic accounts for about one third of all electron microscopes produced. These microscopes are mainly used in the semiconductor chain for quality control. In addition to electron microscopes, companies operating in the Czech Republic are also able to supply optical components for lithography machines and other specialised machines. Czech and Moravian companies are also able to participate in the actual construction of semiconductor factories. They are able to implement clean rooms or supply systems for the distribution of liquids and gases. These companies are already exporting or have considerable export potential that could be developed.

As far as the design of integrated circuits is concerned, both branches of foreign companies and companies owned by domestic capital operate in the Czech Republic. They are engaged in the design of both analogue and digital integrated circuits. However, they mainly develop ASIC chips. Some companies are also involved in general-purpose chip design.

In the area of manufacturing, companies operating in the Czech Republic are able to produce analogue integrated circuits and discrete semiconductor components. However, all companies are of the IDM type. This means that they produce their own integrated circuit designs and discrete semiconductor components and do not provide their manufacturing services to third parties. There is also no custom integrated circuit manufacturer (foundry) in the Czech Republic, and no integrated circuit encapsulation company. Nor is there any company dedicated to the production of logic ICs. Filling these gaps in the supply chain would probably require higher investment incentives.

Possible directions for further development

This chapter describes possible future directions of technology development in the semiconductor sector. It can serve as inspiration for targeting calls for targeted R&D support.

Design of specialised accelerators

This direction focuses on the design of specialized integrated circuits accelerating a specific type of computation. This may include, for example, accelerators for cryptographic operations or machine learning algorithms.

Reducing the size of transistors

Since the invention of the integrated circuit itself, one of the main directions of research and development has been to increase the number of transistors per square centimetre. This development trend has led to an exponential increase in the performance of computing systems, which, due to empirical observation, has led to the formulation of the so-called Moore's law. This states that the number of transistors in an integrated circuit doubles approximately every 18 months, at the same price. This rule has been in force since the 1960s. Recently, however, this pace has slowed down due to technical obstacles, and achieving smaller sizes is becoming more technologically difficult and economically challenging. But it is still a major development trend.

The European Union plans to support two pilot lines under the European Chip Act to support the development of higher density transistor integrated circuits.

Advanced housing

This development direction was greatly aided by the increasing difficulty of shrinking transistors and the susceptibility of monolithic design to manufacturing defects. In memory integrated circuits, layering on top of each other has become a trend. For computing chips, the evolution is towards chiplets, in which multiple integrated circuits (chiplets) are encapsulated on a single package and communicate with each other using interconnect logic. This has led to the physical separation of integrated circuits according to the characteristics of their function. Chiplets can even be produced by different manufacturing technologies. Advanced encapsulation methods can also be applied to power electronics.

The European Union plans to support one pilot line under the Chip Act, which will focus on the development of advanced encapsulation methods.

New semiconductor materials

Historically, silicon has been used as the basic material for integrated circuits. It is cheap, available and production based on it is already well established. However, it is not a perfect material for IC manufacturing. Particularly in the area of power electronics, materials with properties that make them a better alternative to silicon have started to emerge. These include gallium nitride (GaN), silicon carbide (SiC), sapphire and gallium arsenide (GaAs). Research is also underway on diamond-based substrates and other elements and compounds. In addition to the substrate itself, the thin film technology in which the integrated circuit is implemented is also important. These thin films are prepared by epitaxial technologies.

The European Union plans to support one pilot line under the Chip Act, which will focus on the development of new substrate materials.

Photonic systems

Currently, silicon and copper are used as conductors for information processing. The disadvantage of this solution is the slow mobility of electrons. For this reason, computers are nowadays interconnected by means of fibre optic cables, which allow communication at higher speeds. However, the optical signal must be transformed from electrical to electrical when received and the data sent from electrical to optical. There are attempts to create an all-optical computer in which calculations would also be performed with photons rather than electrons.

Integrating AI into the production chain

Artificial intelligence (AI) has significant potential to make integrated circuit manufacturing more efficient and ultimately cheaper. AI can find applications in automating design processes, optimizing integrated circuit performance, reducing power consumption and minimizing manufacturing costs. AI can also be used for rapid prototyping and simulation, making integrated circuit design modifications cheaper and faster. In manufacturing, AI can then be used to optimise production processes and logistics (automating quality control, predictive maintenance, demand forecasting or inventory optimisation).

The National Strategy for Artificial Intelligence of the Czech Republic 2030 deals with artificial intelligence systems in more detail.

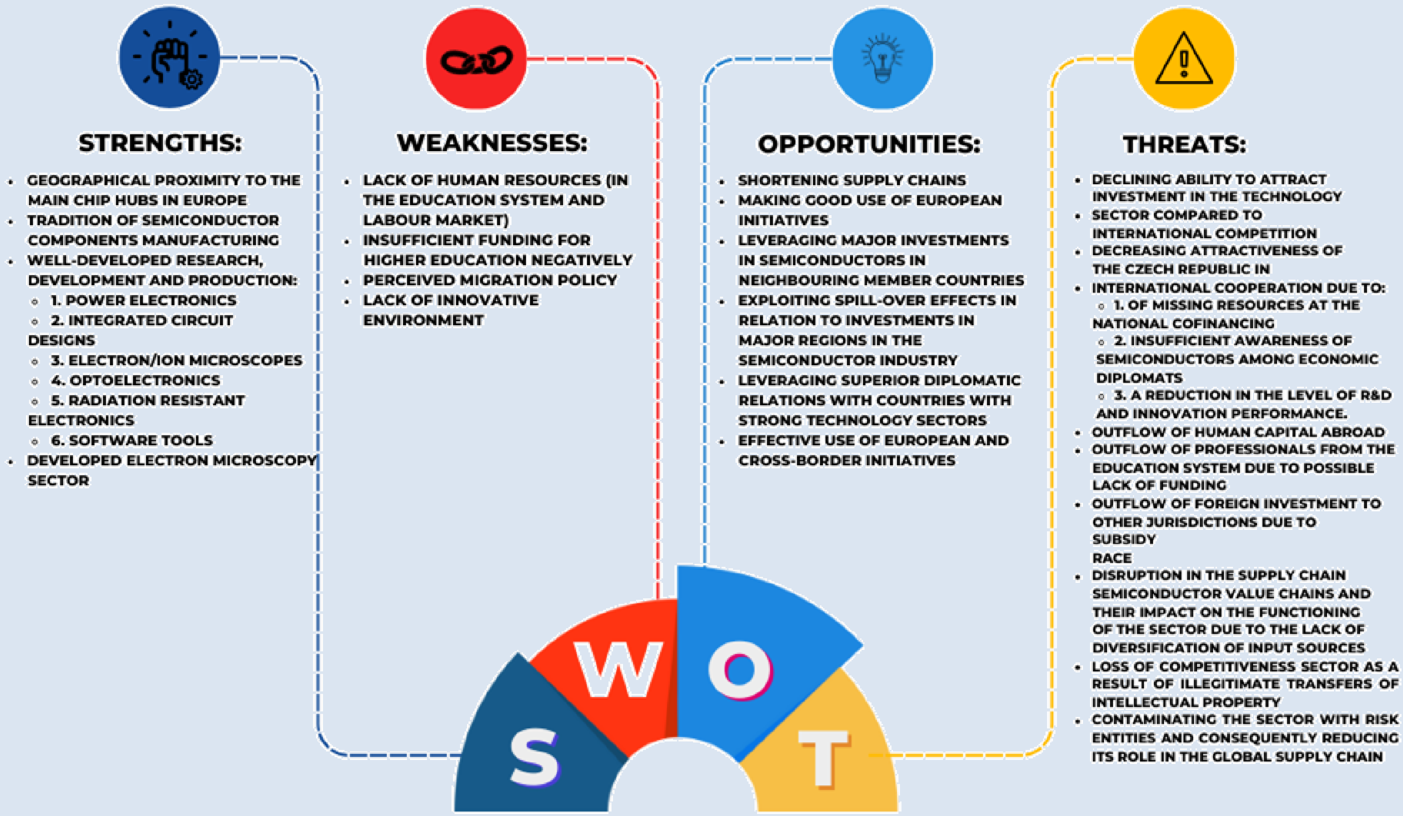
Quantum calculations and simulations

Quantum computing and simulation represent a revolutionary step in computing that is changing the way information is processed and analyzed. While classical computers use bits to process data in binary format (1 or 0), quantum computers use quantum bits, or qubits, which can be in superposition, meaning they can represent multiple states at once. This principle, together with quantum entanglement, should allow quantum computers to perform computations much faster and more efficiently than traditional computers, especially for certain types of problems. However, a quantum computer that demonstrates this property (quantum advantage) has not yet been built. However, the Chip Act also supports this line of research and development.

The National Quantum Strategy addresses quantum technologies in more detail.

SWOT analysis of the Czech semiconductor industry

Conclusion of the analysis



1) The Czech Republic is strong in the production of power electronics. ON Semiconductor Czech Republic and Hitachi Energy mainly participate in this production. Almost 90% of the publicly funded R&D capacity in this area is in Plzeň at ZČU. This type of production is expected to grow at an average annual rate of around 7% in the EU until 2030.
2) The Czech Republic is home to branches of multinational companies specialising in the design of various types of integrated circuits (analogue, mixed and digital). The entire integrated circuit market is expected to grow at around 9.5% per year in the EU until 2029. According to a study by Market Research Future (2024), the average annual growth rate is even expected to be 18% until 2032.
3) Czech capital-owned companies are mostly engaged in designing chips with the RISC-V instruction set. Another focus is on FPGA programming. These activities are less capital-intensive and can therefore be developed with lower initial investment costs and it is also possible to obtain venture capital for them. These activities fall under logic ICs and micro ICs with a projected annual growth rate in the EU of 12,5 % and 4,74 % respectively. The Market Research Future (2024) study again projects a much higher level of average annual growth. However, due to the different data structure, these studies are not fully comparable in the logic IC segment.
4) Another competence of Czech companies and universities is the development and production of radiation-resistant electronics. This will find application especially in healthcare and space applications. Research in this area is carried out by the Czech Technical University, Charles University, Brno University of Technology and Brno University of Technology. Among the companies are ÚJP Praha and members of the Brno Space Cluster.
5) Higher growth in this sector is constrained by a shortage of skilled workers. It is estimated that an additional 350,000 professionals will be needed in the EU to reach a 20% market share in 2030. On a

like-for-like basis and in line with EU data, the shortage of workers in the Czech Republic is estimated at 5 250 directly in semiconductor companies.

6) Interesting target markets, given the Czech Republic's long-standing competencies, are, in addition to the automotive sector, also the cyber security market, space technologies and applications, industrial automation and green energy. The majority of the market potential in the Czech Republic is in transport and energy, given the current structure of the economy. Abroad, it is mainly AI and cyber security.
7) With regard to the Export Strategy of the Czech Republic, it is desirable to strengthen cooperation between Czech companies in order to offer comprehensive solutions on global markets. In the semiconductor industry, for example, cooperation between chip developers and developers of network elements is offered.
8) The supply chain also shows a strong presence of technologically advanced foreign-owned enterprises. This is supported by even more recent acquisitions by foreign investment funds.
9) Czech-owned companies in the supply chain are characterised by their smaller size. Overall, these companies are less technologically advanced but still globally competitive. This is probably due to the capital intensity of the industry.
10) In the Czech Republic, existing suppliers of equipment for the semiconductor sector can be developed. The increase in semiconductor production in Europe may bring new orders to these companies. The CzechInvest Agency is already in talks with Czech semiconductor manufacturers to nominate their Czech suppliers to the planned programme for the development of Czech suppliers in the semiconductor sector.
11) There is scope for an active economic policy to encourage foreign investment, including individual support and investment-ready areas.
12) Public support for the sector has long been minimal. It became more visible only after the semiconductor supply crisis and with the development of diplomatic relations with Taiwan. However, there has been little conceptualisation, which this strategy aims to change.
13) The funds are mainly directed towards basic research and research into suppliers of equipment and materials for the production of semiconductor components.
14) Public support for R&D in the parts of the value chain closest to the final product launch (development of a commercializable solution in semiconductor technology) is marginal.
15) In most of the monitored areas, there was a decrease in financial allocation in 2021 and 2022.

Overall, the semiconductor sector in the Czech Republic has a high potential for further development. The key to this development is the use of European initiatives, stable financing, mutual cooperation between companies, relations with neighbouring and distant countries and efficient use of resources.

It should be noted that massive support for the semiconductor sector is planned or already underway not only by strong European players such as Germany or France, but also by our neighbours such as Poland and Hungary, and that they have already been successful in attracting significant investment.

STRATEGIC PART

STRATEGIC PART

This section defines and describes the strategic objectives of the National Semiconductor Strategy. It also sets out the basic strategic direction in each of the sub-areas. This orientation is further elaborated into specific objectives for each strategic area and the measures that should lead to their fulfilment are defined. The chapter concludes with an analysis of the risks that threaten the fulfilment of the objectives of the National Semiconductor Strategy and a description of their mitigation.

The main objective

1. Support to increase the growth rate of the semiconductor sector in the Czech Republic in order to achieve the Digital Decade goals (to increase the EU share of chip production from 10% to 20% by the end of 2030).

Strategic objectives

1 By the end of 2026, implement the measures defined in the EU Regulation European Chip Act. In particular, the establishment of a national competence centre to serve as an entry point into the European ecosystem to support research, development and innovation in the semiconductor sector. It also involves the cooperation of the centre with pilot lines and the allocation of funds for investment incentives.

2 By the end of 2029, the share of semiconductor technologies in the Czech Republic's exports will increase by 200% compared to 2022.

3 By the end of 2029, at least one virtual institute, at least one national semiconductor research centre, and at least one sector-specific public competition will be established to support applied research in the design or manufacture of integrated circuits or in the design or manufacture of discrete semiconductor components.

4 By the end of 2029, there will be at least 9,000 people working in the Czech economy.

5 By the end of 2029, the production of semiconductor components in the Czech Republic will increase by at least 300% compared to 2022 (in financial terms).

Basic strategic direction in key areas

This chapter sets out the basic strategic direction in each of the sub-strategic areas that are key to meeting the strategic objectives of the National Semiconductor Strategy.

Basic strategic orientation for the implementation of the European Chip Act

It is crucial for the Czech semiconductor ecosystem that the Czech Republic subscribes to the measures described in the European Chips Act and implements them properly. Under the first pillar, it is essential to support the establishment of a Czech competence centre that would provide access to other competence centres, European pilot lines and a cloud-based design platform. The competence centre could also support first industrial deployments. It would therefore be appropriate for the envisaged Competence Centre to cooperate with regional innovation centres to actively offer its services. In particular, the European Commission envisages that the competence centre should support the creation of new fabless companies (integrated circuit designers). Another measure described in the first pillar that the Czech Republic can join is the network of pilot lines. The existing pilot lines will be supplemented by four new ones in the first phase. The Czech Republic should decide whether and how it wants to participate in this initiative.

In the context of the implementation of the second pillar, foreign investment and public support are key to achieving the objectives of the European Chip Act (increased strategic autonomy). In the case of the semiconductor sector, the market is characterised by a high degree of imperfection. Market players are aware that they can obtain large investment subsidies and require them to realise their investments. The Czech Republic needs to be competitive in this area, but at the same time it needs to analyse the benefits of investment incentives for the long-term revenue of the state budget. Also, investments in a sector characterised by higher added value may have different degrees of profitability for the Czech economy and the Czech state budget. It is desirable to have modern, high value-added sectors in our territory. In the short term, it is necessary to attract other representatives of the semiconductor sector to the Czech Republic. In the long term, however, it is not desirable for the Czech Republic to serve only as a manufacturing hub with lower added value, even in sectors with higher added value. When applying for an investment incentive, greater consideration should gradually be given to whether the company has, or intends to have, other parts of the value chain in the Czech Republic in addition to the manufacturing part. For example, whether R&D centres are or will be located in the Czech Republic. However, it would be preferable to locate at least the applicant's regional headquarters so that profits from the sale of final products are realised in the Czech Republic. In addition, the promise of future reinvestments of the applicant and its historical economic behaviour in the territory of our country or cooperation with Czech entities, for example in the form of joint ventures, should be taken into account.

To implement the third pillar, which focuses on monitoring and responding to crises, the Czech Republic should establish a system for data collection and evaluation. This requires a coherent framework for operators to implement projects that contribute to the necessary security of supply of semiconductors. The desired methodology to be followed by the Czech public administration is being prepared by the European Commission, which the Czech Republic will then have to implement.

In addition, a mechanism for monitoring, strategic mapping, crisis prevention and response will be established. This will allow for a timely response to supply problems, prevent obstacles to internal market stability and avoid divergent reactions from Member States. Given the complexity of the semiconductor supply chain and the risk of future shortages, a common tool will therefore be developed at European level for a coordinated approach to strategic mapping and monitoring and to address potential market disruptions. To this end, data will need to be collected from the semiconductor supply chain as well as from end-users.

Basic strategic orientation in the field of exports in the semiconductor sector

In accordance with the Export Strategy 2023 to 2033, export support should be directed in particular towards new national champions that will offer complex solutions and products with high added value on foreign markets. The internationalisation of start-ups, SMEs in the semiconductor sector that offer unique products and solutions that are highly competitive in challenging markets with high added value and beyond integrated solutions should also be supported.

Japan, South Korea and Taiwan appear to be attractive markets for the export of semiconductor component manufacturing equipment. These are mature markets with a strong technology sector. The focus on these target markets is in line with the export diversification strategy. Other Asian markets may also be of interest. In the European Union, export opportunities for Czech suppliers of semiconductor manufacturing equipment will be mainly in Germany, Ireland, France and Italy, which is linked to the investment flowing into the semiconductor sector in these countries.

Exports of semiconductor components ("chips") and their designs are not geographically specific. However, higher demand will occur in mature markets due to the higher incidence of technology firms and higher value-added product manufacturers demanding integrated circuits (chips).

Basic strategic orientation in the field of public support for research and development activities in the semiconductor sector

In line with the proposal for measures to support selected strategic technologies (semiconductors, artificial intelligence, quantum technologies), support for research, development and innovation activities across the entire research and innovation cycle, from excellent centres of excellence focused on basic and oriented research, through support for effective cooperation in applied research between research organisations and enterprises, R&D in enterprises, with a focus on technology transfer, including a focus on power electronics. Increased involvement in European and international initiative schemes should also be an important element.

The development of the semiconductor industry can also be used to strengthen investment linked to R&D and innovation activities in structurally affected regions and thus promote innovation cohesion.

Basic strategic direction in the field of human resources

There is a growing demand for highly skilled human resources throughout the developed world. The Czech environment is no exception. On the basis of the analytical part, it is estimated that to achieve the objectives of the strategy, human resource capacities need to be significantly strengthened. Given the time horizon for setting the targets (6 years), it is not possible to rely on the formal education system alone. Rather, the focus should be mainly on upscaling and rescaling of the current workforce in the ICT industry and other technical professions, as well as on a significant increase in labour migration of highly qualified persons, both from EU and non-EU countries. This requires mapping the current and future needs of the sector. In the long term, however, emphasis should be placed on the formal education system, which should be the main source of talent in the sector. To this end, an adequate funding system needs to be set up and the promotion of STEM subjects (mathematics, physics, chemistry, biology, ICT...) at all levels of the education system needs to be focused on.

Basic strategic direction in the area of promoting strategic autonomy

In order to strengthen the strategic autonomy of the European Union and the Czech Republic, it is necessary, in addition to actively addressing foreign investors, to support domestic components in the semiconductor sector. This includes strengthening domestic small and medium-sized enterprises, which mostly produce equipment for the production of semiconductor components in the context of the Czech semiconductor sector, as well as dynamic start-ups.

The Czech Republic has a number of small and medium-sized enterprises with unique products and unfulfilled export potential. It is in the interest of the Czech Republic to help these companies to actively market their products abroad. To do this, it is necessary to identify such 'potential national champions' and help them to develop.

Equally deserving of attention is support for the creation of start-up companies, which are usually the carriers of innovation. Support for these companies through the Chips Fund and Pillar I is already envisaged in the Chips Act itself. The Czech Republic should also support these companies beyond the measures set out in the Act. Especially in the area of their creation.

The dynamic development of the semiconductor industry should also be used to address regional disparities. The achievement of the strategy's objectives can be supported in some regions through the Operational Programme for Fair Transformation and the Re: Start programme.

Specific objectives

Strategic Objective 1: Implement the measures defined in the EU Regulation European Chip Act by the end of 2026.

1. Pillar I. By the end of the first half of 2025, a Chip Competence Centre will be established as part of a pan-European network.
2. Pillar I. By the end of 2024, a decision will be made on whether to participate in the pilot lines programme.
3. Pillar II. By the end of 2024, CZK 20 billion will be secured for strategic investments from the state budget in this area for the years 2025 to 2029.
4. Pillar II. By the end of 2026, consideration will be given to implementing the priority approach in the permitting process for the construction of semiconductor fabs.
5. Pillar III. A system for monitoring the semiconductor chain in the Czech Republic will be implemented by the end of 2024.

Strategic objective 2: By the end of 2029, the share of semiconductor technologies in the Czech Republic's exports will increase by 200% compared to 2022.

1. By the end of 2024, a comprehensive overview of the capabilities of the Czech semiconductor supply chain will be developed.
2. By the end of 2024, recommendations on how to promote the semiconductor sector abroad will be developed and provided to the Czech embassies and foreign offices of the CzechInvest and CzechTrade agencies.
3. By the end of 2024, recommendations will be developed and provided to the Czech embassies and foreign offices of the CzechInvest and CzechTrade agencies on how to promote Czech research activities in the field of semiconductors abroad.
4. By the end of 2024, a plan for participation in fairs and exhibitions abroad in the field of semiconductors will be developed, including how to secure funding for them. The goal is to implement 2 to 3 official Czech participation in key semiconductor trade fairs abroad, such as Semicon or Electronica, per year.

Strategic Objective 3: In order to stabilise the research and innovation base for the development of semiconductor technologies, a minimum of CZK 300 million per year will be provided for research and

development in the field of semiconductor technologies, including integrated circuit design, by the end of 2029.

1. By the end of 2025, a dedicated support programme will be in place to support excellent research teams.
2. By the end of 2025, a public competition will be prepared in the SIGMA programme to support long-term research projects - National Research Centres.
3. By the end of 2025, public tenders will be launched under the MIT TWIST programme to support projects focused on semiconductor technologies.

Strategic Goal 4: By the end of 2029, there will be at least 9,000 semiconductor professionals working in the Czech economy.

1. By the end of 2024, the requirements for specialisations and the numbers of graduates will be mapped based on employer data with a view to 2030 as an input for sizing an adequate education system.
2. By the end of 2026, a system for promoting STEM in primary and secondary schools will be designed and implemented.
3. By the end of 2026, a system of support for relevant study programmes at universities will be designed and implemented.
4. By the end of 2026, a system of support for relevant lifelong learning courses (culminating in micro-certificates) in the technology sector will be designed and implemented.
5. By the end of 2027, a system of promotion of relevant study programmes with the possibility of studying in foreign and Czech languages for potential applicants from abroad will be designed and implemented.
6. By the end of 2029, 2,000 new qualified foreign professionals will be working in the semiconductor sector in the Czech Republic.
7. By 2026, highly qualified foreign professionals will be able to communicate with the Czech immigration service in English in matters of residence in the Czech Republic.

Strategic objective 5: By the end of 2029, the production of semiconductor components in the Czech Republic will increase by at least 300% compared to 2022 (in financial terms).

1. By the end of 2024, a working group will be established at CzechInvest to evaluate foreign opportunities in the field of semiconductor technologies.
2. By the end of 2029, 6 new companies will be established in the Czech Republic in the semiconductor sector.
3. By the end of 2024, a programme for the development of Czech suppliers to the semiconductor sector will be completed and launched.
4. By the end of 2024, support for notified projects under the approved IPCEI for microelectronics and communication technologies will be launched.
5. By the end of 2024, a programme will be launched to support the development of regional ecosystems for the semiconductor sector in selected regions of the Czech Republic with lower economic performance.

Action cards

Strategic objective 1: Implementation of the EU Regulation European Chip Act

Nine actions are proposed under Strategic Objective 1. Two actions are aimed at implementing specific objective 1.1: "Pillar I. Establishment of a national competence centre to provide access to a design platform (EDA tools) that will be part of a pan-European network of design competence centres". Task 1.1.A aims to ensure co-financing of the competence centre. The MoEYS is responsible for the implementation of the task.

Task 1.1.A	
Specific objective	Pillar I. By the end of the first half of 2025, a Chip Competence Centre will be established as part of a pan-European network.
Objective of the measure	Clarify the source of national co-financing by the end of the first half of 2024.
Description of measures	Co-financing of the national competence centre (estimated at CZK 25 million per year) for 4 years must be ensured.
Responsibility	MOE
Collaboration	MIT, IOI/RVVI together with industry partners and regional partners
Dependence on the measure	Not
Date of introduction	Q3 2024
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	The Competence Centre should provide access to the DG CNECT design platform (IP, EDA and other tools) and pilot lines. It should also be involved in training.
Implementation time	From the beginning of 2024 to the end of 2024
Fulfilment indicator	Funds will be allocated for a national competence centre

Task 1.1.B builds on Task 1.1.A. On the basis of the funding received, a call for funding for the competence centre should be launched. The MoEYS is responsible for the implementation of the tasks.

Task 1.1.B	
Specific objective	Pillar I. By the end of the first half of 2025, a Chip Competence Centre will be established as part of a pan-European network.
Objective of the measure	By the end of the first half of 2024, launch a call for expressions of interest for the establishment of a national competence centre and select candidates for the 2nd phase of the international evaluation of Chips JU.
Description of measures	Call for expressions of interest for the establishment of a national competence centre and selection of 1 or more candidates to proceed to the 2nd phase of the international evaluation of Chips JU after the completion of Task 1.1. A.

Task 1.1.B	
Responsibility	MOE
Collaboration	ÚV/RVVI
Dependence on the measure	On task 1.1.A
Date of introduction	Q3 2024
Cost	Minimum CZK 100 million (CZK 25 million per year)
Benefits	The competence centre should provide access to the DG CNECT Chips JU design platform (IP, EDA and other tools) and pilot lines. It should also be involved in training.
Implementation time	From Q3 2024 to 2028
Fulfilment indicator	A call for expressions of interest for the establishment of a national competence centre will be launched and a candidate will be selected for the 2nd phase of the international evaluation of Chips JU.
Budget chapter	MOE

Three tasks are proposed under specific objective 1.2: "Pillar I. Engage in the pilot lines programme". The first task (Task 1.2.A) aims to establish cooperation with one of the emerging consortia under the planned calls launched by the Chips JU. The MoEYS is responsible for the implementation of the task.

Task 1.2.A	
Specific objective	Pillar I. By the end of 2024, a decision will be made on whether to participate in the pilot lines programme.
Objective of the measure	Determine the interest of entities from the Czech Republic in joining the emerging consortia operating a pilot line.
Description of measures	The Chips JU is continuously launching calls for project proposals to build pilot lines in specific areas. The aim of the measure will be to test the interest of entities from the Czech Republic to participate in these projects.
Responsibility	MOE
Collaboration	ÚV/RVVI, MIT and industrial partners
Dependence on the measure	Not
Date of introduction	2nd half of 2024
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	The Czech Republic would have direct access to the know-how gained from the operation of the pilot line.

Task 1.2.A	
Implementation time	From the end of 2025 to the end of 2029
Fulfillment indicator	A report will be produced on the indicative interest of entities from the Czech Republic in joining the pilot lines programme.

Task 1.2.B aims to support negotiations with the selected consortium on the access of partners from the Czech Republic and, if successful, to secure the necessary financial resources. The MoEYS is responsible for the implementation of the task.

Task 1.2.B	
Specific objective	Pillar I. By the end of 2024, a decision will be made on whether to participate in the pilot lines programme.
Objective of the measure	Ensure national co-funding in the event that an entity is a member of a consortium operating one of the pilot lines.
Description of measures	If any of the entities from the Czech Republic will be a member of the consortium operating one of the emerging pilot lines within the framework of the calls announced by the Chips JU, it will be necessary to find the necessary financial resources at the level of the Czech Republic to finance the operation of the pilot line.
Responsibility	MOE
Collaboration	IAC/RVVI, MIT, MFA and industrial partners
Dependence on the measure	Task 1.2.A
Date of introduction	2nd half of 2024
Cost	Minimum CZK 250 million (CZK 50 million per year).
Benefits	The Czech Republic would have direct access to the know-how gained from the operation of the pilot line.
Implementation time	From the end of 2025 to the end of 2029
Fulfilment indicator	Funds will be allocated for national co-financing.
Budget chapter	MOE

Task 1.2.C focuses on exploring the possibility of creating an international consortium with Czech leadership (e.g., ECIC) to operate the pilot line. Responsibility for the task lies with the Ministry of Education and Science.

Task 1.2.C	
Specific objective	Pillar I. By the end of 2024, a decision will be made on whether to participate in the pilot lines programme.

Task 1.2.C	
Objective of the measure	Explore the possibility of creating an international consortium (e.g., ECIC) to operate the pilot line.
Description of measures	There will be an opportunity to submit proposals to Chips JU to fund additional pilot lines in additional calls in 2025 and 2026. The Czech Republic should determine whether it has the ambition to apply to operate a pilot line. If this ambition exists, it should start reaching out to partners and actively communicate with Chips JU and European Commission representatives.
Responsibility	MOE
Collaboration	IAC/RVVI, MFA, MIT and industrial partners
Dependence on the measure	Not
Date of introduction	By the first half of 2025
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	The Czech Republic would have direct access to the know-how gained from the operation of the pilot line. International prestige would also be associated with the operation of the pilot line.
Implementation time	2nd half of 2025 to end of 2025
Fulfilment indicator	A dossier will be drawn up on whether and under what conditions it is possible to apply to operate the pilot line.

Task 1.2.C is linked to Task 1.2.B. If Task 1.2.C is fulfilled and the consortium is successful in the relevant call, funding must be secured on the basis of a consortium agreement. Responsibility for the completion of the tasks lies with the MoEYS.

Task 1.2.D	
Specific objective	Pillar I. By the end of 2024, a decision will be made on whether to participate in the pilot lines programme.
Objective of the measure	Secure funding for a Czech-led pilot line.
Description of measures	If Objective 1.2.C is met and the consortium is successful in the relevant call, secure funding on the basis of a consortium agreement. The total cost of the consortium is estimated at EUR 100 million (EUR 50 million EU funding and EUR 50 million national co-financing).
Responsibility	MOE
Collaboration	MIT and IU/RVVI

Task 1.2.D	
Dependence on the measure	On task 1.2.C
Date of introduction	2025 to 2029
Cost	Approximately CZK 350 million in investment costs and CZK 100 million in operating costs
Benefits	The Czech Republic would have direct access to the know-how gained from the operation of the pilot line. International prestige would also be associated with the operation of the pilot line.
Implementation time	2025 to the end of 2029
Fulfilment indicator	Funds (national co-financing) will be allocated for a pilot line under Czech leadership.
Budget chapter	MOE

Under specific objective 1.3: "Pillar II. Provide resources for strategic investments in this area", one task (Task 1.3.A) is proposed to establish a budget for investment incentives for strategic investments falling under Pillar II of the European Chip Act. The MIT is responsible for the implementation of this task.

Task 1.3. A	
Specific objective	Pillar II. By the end of 2024, CZK 20 billion will be secured for strategic investments from the state budget in this area for the years 2025 to 2029.
Objective of the measure	Establish an investment support plan and possible forms of support for strategic investment actions.
Description of measures	Establishing a plan for investment incentives for strategic investments falling under Pillar II. It would also be useful to clarify the possible form of public support. Furthermore, it would be useful to discuss (rethink) the possibility of a programme for investment in the semiconductor sector with reference to the common interest of the European economy. In this way, the Czech Republic can gain a comparative advantage and actively approach investors.
Responsibility	MIT
Collaboration	MF (this is not a cooperation concerning the provision of financing) and CzechInvest
Dependence on the measure	Not
Date of introduction	By the first half of 2025
Cost	CZK 20 billion (government approval required for individual incentives, may not be fully exhausted)
Benefits	With a set allocation for investment incentives, it would be possible to plan and actively approach potential investors with a specific offer of public support.

Task 1.3. A	
Implementation time	From the 2nd half of 2025 to the end of 2029
Fulfilment indicator	At least one plan will be developed.
Budget chapter	MIT

Under specific objective 1.4: "Pillar II. Accelerating the permitting process for the construction of semiconductor fabs", two tasks are proposed. The first task (Task 1.4.A) aims, under Pillar II of the Chip Act, to consider the implementation of accelerated permitting processes for strategic investment actions falling under Pillar II of the Chip Act. The MIT is responsible for the implementation of the task.

Task 1.4.A	
Specific objective	Pillar II. By the end of 2026, consideration will be given to implementing a priority approach in the permitting process for the construction of semiconductor fabs.
Objective of the measure	Consider the legislative anchoring of "fast-track" in the construction permitting procedure for strategic investment projects in the semiconductor sector.
Description of measures	According to Pillar II of the Act on Chips, consider implementing the provisions of Pillar II of the Act on Chips enabling the acceleration of permitting processes for strategic investment projects falling under Pillar II, namely to include strategic investment projects, including possible semiconductor production in defined locations, as public utility projects within the Act on Accelerating the Construction of Strategically Important Infrastructure. At the same time, it is necessary to add the sites that should be suitable for the location of semiconductor investors to the existing list of sites in Annex 3 of the Act.
Responsibility	MIT
Collaboration	MMR, MoE and MoD
Dependence on the measure	Not
Date of introduction	2025
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	Faster permitting and construction of strategic investment projects.
Implementation time	From the beginning of 2025 to the end of the first half of 2025
Fulfillment indicator	A basis will be created with a conclusion on whether it is appropriate and, if necessary, how the accelerated building permit procedure for strategic investment projects in the semiconductor sector can be anchored in legislation.

The second task (Task 1.4.B) is aimed at the implementation of the acceleration of the permitting processes for strategic investment actions falling under the second pillar of the Chip Act under Pillar II of the Chip Act. The MIT is responsible for the implementation of the task.

Task 1.4.B	
Specific objective	Pillar II. By the end of 2026, consideration will be given to implementing a priority approach in the permitting process for the construction of semiconductor fabs.
Objective of the measure	Implement "fast-track" in the construction permitting process for strategic investment projects in the semiconductor sector.
Description of measures	According to Pillar II of the Chip Act, to implement the provisions of Pillar II of the Chip Act enabling the acceleration of permitting processes for strategic investment projects falling under Pillar II, namely to include strategic investment constructions, including possible semiconductor production in defined locations, as public utility constructions within the Act on Accelerating the Construction of Strategically Important Infrastructure (Linear Act). At the same time, it is necessary to add the sites that should be suitable for the location of semiconductor investors to the existing list of sites in Annex 3 of the Act.
Responsibility	MIT
Collaboration	MMR, MoE and MoD
Dependence on the measure	On task 1.4.A
Date of introduction	By the end of 2026
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	Faster permitting and construction of strategic investment projects.
Implementation time	From the 2nd half of 2025 to the end of 2026
Fulfilment indicator	An amendment to the Act on Accelerating the Construction of Strategically Important Infrastructure will be approved.

Under specific objective 1.5: "Pillar III. Implementation of the semiconductor chain monitoring system", two tasks are proposed. The first task (Task 1.5.A) aims to develop a methodology for data collection and evaluation in line with Pillar III. Act. The MIT is responsible for the implementation of the task.

Task 1.5.A	
Specific objective	Pillar III. A system for monitoring the semiconductor chain in the Czech Republic will be implemented by the end of 2024.
Objective of the measure	Develop a methodology for data collection and evaluation in line with Pillar III. Act.
Description of measures	Under Pillar III of the Chip Act, an "early warning" system should be set up for further shortfalls in semiconductor component production. As part of the national implementation, a methodology for collecting and processing data on the production of semiconductor components in the Czech Republic and their demand should be proposed.

Task 1.5.A	
Responsibility	MIT
Collaboration	CSU, academic institutions and industrial partners, CzechInvest
Dependence on the measure	Not
Date of introduction	By the first half of 2025
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	Establishing an early warning system for critical component outages.
Implementation time	From the 2nd half of 2024 to the 1st half of 2025
Fulfilment indicator	A methodology for data collection and evaluation will be developed in line with Pillar III. Act on Chips

The second task (Task 1.5.B) builds on Task 1.5.A. If Task 1.5.A is completed, the developed methodology for collecting and evaluating data on the semiconductor supply chain needs to be applied. The MIT is responsible for completing the tasks.

Task 1.5.B	
Specific objective	Pillar III. Implementation of a semiconductor chain monitoring system.
Objective of the measure	Apply the methodology for data collection and evaluation in line with Pillar III. Act.
Description of measures	Under Pillar III of the Chip Act, an "early warning" system should be set up for further shortfalls in semiconductor component production. As part of national implementation, a methodology for collecting and processing data on the production of semiconductor components in the Czech Republic and their demand should be applied.
Responsibility	MIT
Collaboration	CSU, academic institutions and industrial partners, CzechInvest
Dependence on the measure	On task 1.5. A
Date of introduction	By the 2nd half of 2025
Cost	1 million CZK
Benefits	Establishing an early warning system for critical component outages.
Implementation time	From the 2nd half of 2025

Task 1.5.B	
Fulfilment indicator	A methodology for data collection and evaluation in line with Pillar III will be applied. Act on Chips
Budget chapter	MIT

Strategic objective 2: By the end of 2029, the share of semiconductor technologies in the Czech Republic's exports will increase by 200% compared to 2022.

Four specific objectives are proposed under Strategic Objective 2. Each specific objective is implemented through one measure. Under specific objective 2.1: "By the end of 2024, a comprehensive overview of the capabilities of the Czech semiconductor supply chain will be developed" The MIT is responsible for the achievement of the task.

Task 2.1.A	
Specific objective	By the end of 2024, a comprehensive overview of the capabilities of the Czech semiconductor supply chain will be developed.
Objective of the measure	Creation of a comprehensive material to provide economic diplomats with an overview of the products on offer and opportunities for cooperation.
Description of measures	The material should contain products with export potential.
Responsibility	MIT
Collaboration	MFA, CzechInvest, CzechTrade and industrial partners
Dependence on the measure	Not
Date of introduction	By the end of 2024
Cost	25 thousand CZK
Benefits	Improving the promotion of Czech companies.
Implementation time	From 2024 until the material is updated
Fulfilment indicator	Material will be created containing an overview of the capabilities of the Czech semiconductor chain
Budget chapter	MIT

Under specific objective 2.2: "By the end of 2024, recommendations on how to promote the semiconductor sector abroad will be developed and sent to embassies." The MIT is responsible for the implementation of the task.

Task 2.2.A	
Specific objective	By the end of 2024, recommendations on how to promote the semiconductor sector abroad will be developed and sent to Czech embassies and CzechTrade offices abroad.
Objective of the measure	A written recommendation will be drafted and sent to Czech embassies and CzechTrade offices abroad.
Description of measures	The recommendations should describe the competencies of the Czech semiconductor chain and the potential customers that would need to be supported for possible export.
Responsibility	MIT
Collaboration	MFA, CzechInvest, CzechTrade and industrial partners
Dependence on the measure	Not
Date of introduction	By the end of 2024
Cost	25 thousand CZK
Benefits	Targeting the promotion of Czech companies in the field of semiconductors.
Implementation time	From 2024 until the material is updated
Fulfilment indicator	A material containing recommendations on how to promote the semiconductor sector abroad will be created and this material will be sent to the Czech embassies and foreign offices of CzechTrade and CzechInvest.
Budget chapter	MIT

Within the framework of specific objective 2.3: "By the end of 2024, recommendations will be developed and sent to embassies on how to promote Czech research activities abroad." Responsible for the implementation of the task is the Ministry of Education and Science.

Task 2.3.A	
Specific objective	By the end of 2024, recommendations will be developed and provided to the Czech embassies and foreign offices of the CzechInvest and CzechTrade agencies on how to promote Czech research activities in the field of semiconductors abroad.
Objective of the measure	Creating a written recommendation and sending it to the embassies.
Description of measures	The recommendations should describe in which areas Czech research organisations and highly innovative companies have deep expertise and where there are potential areas of common interest or scope for mutual cooperation.
Responsibility	ÚV/RVVI
Collaboration	Ministry of Foreign Affairs, Ministry of Education, research organisations and industrial partners

Task 2.3.A	
Dependence on the measure	Not
Date of introduction	By the end of 2024
Cost	25 thousand CZK
Benefits	Facilitating the work of economic and scientific diplomats and promoting international cooperation in R&D and innovation.
Implementation time	From 2024 until the material is updated
Fulfillment indicator	A material containing recommendations on how to promote Czech research activities in the field of semiconductors abroad will be created and this material will be sent to Czech embassies and CzechInvest offices abroad.
Budget chapter	IU/MVVI/RVVI

Under specific objective 2.4: "By the end of 2024, a plan for the Czech Republic's participation with a national stand at international trade fairs will be developed." The MIT is responsible for the implementation of the task.

Task 2.4.A	
Specific objective	By the end of 2024, a plan for participation in fairs and exhibitions abroad in the field of semiconductors will be developed, including how to secure funding for them. The goal is to implement 2 to 3 official Czech participation in key semiconductor trade fairs abroad, such as Semicon or Electronica, per year.
Objective of the measure	Creation of a plan for the Czech Republic's participation in selected exhibitions, conferences and trade fairs relevant to the semiconductor sector.
Description of measures	A plan should be drawn up, updated annually, describing the Czech Republic's interest in participating in selected trade fairs, conferences and exhibitions.
Responsibility	MIT
Collaboration	MFA, CzechInvest, CzechTrade and industrial partners
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	CZK 60 million (CZK 12 million per year - the cost of one official Czech participation in foreign trade fairs, such as Semicon, Electronica for 8 to 10 exhibiting Czech exporters is on average CZK 4 million. CZK. The annual cost of three events of this type is therefore CZK 12 million. CZK).
Benefits	Raising awareness of national competencies, increasing export volumes.

Task 2.4.A	
Implementation time	From 2024 until the material is updated
Fulfilment indicator	A plan for the Czech Republic's participation in selected exhibitions, conferences and trade fairs relevant to the semiconductor sector will be developed
Budget chapter	MIT

Strategic objective 3: By the end of 2029, at least one virtual institute, at least one national semiconductor research centre and at least one sector-specific public competition will be established to support applied research in the design or manufacture of integrated circuits or in the design or manufacture of discrete semiconductor components.

Three specific objectives and three actions are proposed under Strategic Objective 3. The first measure (Target 3.1.A) is aimed at the implementation of Specific Objective 3.1: "By the end of 2025, a programme of dedicated support aimed at supporting excellent research teams will be in place." The objective of the measure is to prepare a dedicated support programme to financially support excellent research teams, based on secured funding. The MoEYS is responsible for the implementation of the task.

Task 3.1.A	
Specific objective	By the end of 2025, a dedicated support programme will be in place to support excellent research teams.
Objective of the measure	Establish a dedicated support programme to provide financial support to excellent research teams.
Description of measures	Prepare a programme of earmarked support for research, development and innovation in support of a virtual institute bringing together excellent research teams, possibly including so-called Technology Chairs, with an emphasis on strengthening the interdisciplinarity of research and development and on creating conditions for the development of human resources in research and development centred around prominent domestic or foreign personalities.
Responsibility	MOE
Collaboration	ÚV/RVVI
Dependence on the measure	On task 3.1. A
Date of introduction	2026
Cost	Approximately CZK 600 million (CZK 150 million per year)
Benefits	Ensuring long-term funding for excellent research teams to support long-term systematic work on fundamental discoveries and innovations.
Implementation time	from 2026 to 2029

Task 3.1.A	
Fulfilment indicator	A dedicated support programme will be set up to provide financial support to excellent research teams.
Budget chapter	MOE

Under specific objective 3.2: "By the end of 2025, a public competition will be prepared in the SIGMA programme to support long-term research projects - National Research Centres." The aim of the measure is to prepare a public competition to support a long-term plan for a consortium of research organisations and companies focused on applied research in the field of semiconductor technologies, which will aim to create a national centre for research in these technologies. The Czech Technology Agency is responsible for the task.

Task 3.2.A	
Specific objective	By the end of 2025, a public competition will be prepared in the SIGMA programme to support long-term research projects - National Research Centres.
Objective of the measure	By the end of 2025 and if the budget is secured, a public competition will be prepared in the SIGMA programme to support National Research Centres.
Description of measures	Long-term plans of a consortium of research organisations and companies focused on applied research in the field of semiconductor technologies will be supported, which will aim to create national research centres in these technologies with an annual estimated budget of CZK 50 million.
Responsibility	TA ČR
Collaboration	MIT and IU/RVVI
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	Estimated budget: 350 million CZK (with a gradual ramp-up)
Benefits	Promoting technology transfer and collaboration between commercial and academic institutions.
Implementation time	From 2026 to the end of 2031
Fulfilment indicator	One call for tenders for National Research Centres will be launched.
Budget chapter	TA ČR

Under specific objective 3.3: "By the end of 2025, public tenders will be launched under the MIT TWIST programme to support projects focused on semiconductor technologies." One measure has been proposed. The aim of the measure is to launch public tenders specifically targeting semiconductor technologies. The MIT is responsible for the implementation of the task.

Task 3.3. A	
Specific objective	By the end of 2025, tenders will be prepared under the MIT TWIST programme to support projects focused on semiconductor technologies.
Objective of the measure	From 2025, public competitions specifically focused on semiconductor technologies will be launched
Description of measures	Within the MIT TWIST programme, public competitions specifically focused on semiconductor technology or integrated circuit design will be announced from 2025.
Responsibility	MIT
Collaboration	Not
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	No additional budgetary requirements on the expenditure side of the budget. The TWIST programme should be approved independently of the National Semiconductor Strategy. We foresee a financial allocation from the programme of CZK 50 million per year (total of CZK 250 million).
Benefits	Support for the development of new innovative products with higher added value.
Implementation time	From the beginning of 2025 to the end of 2029
Fulfilment indicator	There will be at least one competition focused on semiconductor technology or integrated circuit design

Strategic Goal 4: By the end of 2029, there will be at least 9,000 semiconductor professionals working in the Czech economy

Under strategic objective 4, 6 specific objectives have been specified. Under the first specific objective "By the end of 2024, the requirements for specialisations and the number of graduates will be mapped on the basis of employers' data with a view to 2029, as an input for sizing an adequate education system." Two measures are proposed. The first measure, Task 4.1.A, focuses on mapping workforce requirements. The MoEYS is the lead agency for this measure.

Task 4.1.A	
Specific objective	By the end of 2024, the requirements for specialisations and the numbers of graduates will be mapped based on employer data with a view to 2030, as an input for sizing an adequate education system.
Objective of the measure	Identification of specific knowledge requirements for graduates not only of HEIs but also of SHS, requirements for numbers of graduates by 2030 in all relevant professions of SVC and in all levels of education, not only HEIs.

Task 4.1.A	
Description of measures	An extensive qualitative and quantitative survey will be conducted among all types of employers within the SVCs in the Czech Republic. Primarily, this will include industrial enterprises of all sizes, but also research organisations and universities.
Responsibility	MIT
Collaboration	Industrial partners, universities, the Ministry of Labour and Social Affairs and the Ministry of Education
Dependence on the measure	Not
Date of introduction	2nd half of 2024
Cost	No additional cost on the expenditure side of the budget.
Benefits	Detailed analysis of the knowledge requirements of graduates not only from HEIs but also from SHS, the requirements for the number of graduates by 2030 in all relevant professions of SVC and in all levels of education, not only HEIs. Taking into account the prediction of the demographic development of the numbers of graduates from SVCs, which will be translated into the numbers of potential students from HEIs.
Implementation time	From the 2nd half of 2024
Fulfilment indicator	A final report will be produced from the employer survey containing requirements for specialisations and numbers of graduates based on employer data with a view to 2030 as input for sizing an adequate education system.

The second measure, Task 4.1.B, focuses on mapping the education system in tertiary education. The measure is again led by the Ministry of Education and Science.

Task 4.1.B	
Specific objective	By the end of 2024, the requirements for specialisations and the numbers of graduates will be mapped based on employer data with a view to 2030, as an input for sizing an adequate education system.
Objective of the measure	Establish an analytical basis on the current numbers of students and graduates in key programmes, including drop-out and enrolment rates.
Description of measures	Based on the request defined by the MIT, the MIT will add the numbers of students and graduates of selected study programmes from its databases.
Responsibility	MOE
Collaboration	MIT, Universities
Dependence on the measure	4.1. A
Date of introduction	By the end of 2024

Task 4.1.B	
Cost	No additional cost on the expenditure side of the budget.
Benefits	Improved decision-making and planning options.
Implementation time	3rd quarter of 2024 by the end of 2024
Fulfilment indicator	An analytical basis will be created containing the current number of students and graduates in key programmes, including the drop-out rate.

To meet the second specific objective "By the end of 2026, a system for promoting STEM in primary and secondary schools will be designed and implemented." Two measures are proposed to promote STEM in secondary and higher education. For the first measure "Design a system to promote STEM in primary and secondary schools." is the responsibility of the Ministry of Education.

Task 4.2. A	
Specific objective	By the end of 2026, a system for promoting STEM in primary and secondary schools will be designed and implemented.
Objective of the measure	Design a system for promoting STEM in primary and secondary schools, including addressing entrenched systemic problems, particularly the significant gender gap in interest in studying the subject.
Description of measures	The MoEYS will propose ways to promote STEM in primary and secondary schools.
Responsibility	MOE
Collaboration	MIT, universities, secondary schools, primary schools, regions and municipalities
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	350 thousand CZK
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	1st half 2025 to end 2025
Fulfilment indicator	Material will be produced proposing a system for promoting STEM in primary and secondary schools, including addressing entrenched systemic problems, particularly the significant gender gap in interest in studying the subject.
Budget chapter	MOE

Measure 2 "Implement the measures proposed in Task 4.2.A - Design a system to promote STEM in elementary and secondary schools." The MoEYS is responsible for the implementation of the measure.

Task 4.2.B	
Specific objective	By the end of 2026, a system for promoting STEM in primary and secondary schools will be designed and implemented.
Objective of the measure	Implement the measures proposed in Task 4.2.A "Design a system for promoting STEM in primary and secondary schools."
Description of measures	The MoEYS is implementing the proposed measures to promote STEM in primary and secondary schools. Measures would include on-site visits and seminars for primary/elementary school students, support for women in STEM.
Responsibility	MOE
Collaboration	Primary, secondary and higher education institutions, regions, municipalities, industry partners, non-profit organisations and MIT
Dependence on the measure	On task 4.2.A
Date of introduction	By the end of 2026
Cost	100 million CZK (25 million CZK per year)
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	2nd half of 2026 to end of 2029
Fulfilment indicator	The proposed system for promoting STEM fields developed under Measure 4.2.A will be implemented.
Budget chapter	MOE

Third specific objective "By the end of 2026, a system of support for relevant fields of study at universities will be designed and implemented." is supported by two measures aimed at promoting technical disciplines in universities. The first measure is to propose a way to possibly support key disciplines in universities. The Moseys is responsible for the implementation of the measure.

Task 4.3. A	
Specific objective	By the end of 2026, a system of support for relevant study programmes at universities will be designed and implemented.
Objective of the measure	To propose a way of possible support for key study programmes in universities according to the defined public interest.
Description of measures	Developing a draft commitment for universities to support key programmes of study according to pre-defined outcomes.
Responsibility	MOE

Task 4.3. A	
Collaboration	MIT and universities
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	350 thousand CZK
Benefits	Increase the number of graduates of key study programmes and therefore job seekers in the technology sector.
Implementation time	1st half 2025 to end 2025
Fulfilment indicator	A paper will be produced proposing ways in which key study programmes at universities can be supported.
Budget chapter	MOE

The second measure is aimed at implementing support for key disciplines at universities. The MoEYS is responsible for the implementation of the measure.

Task 4.3. B	
Specific objective	By the end of 2026, a system of support for relevant disciplines at universities will be designed and implemented.
Objective of the measure	Implementation of university measures focusing on the preparation of graduates in key study programmes
Description of measures	Implementation of university measures focusing on the preparation of graduates in key study programmes according to defined conditions.
Responsibility	MOE
Collaboration	MIT and universities
Dependence on the measure	On task 4.3. A
Date of introduction	By the end of 2026
Cost	100 million CZK
Benefits	Increase the number of graduates in key degree programmes and therefore job seekers in the technology sector.
Implementation time	2nd half of 2026 to end of 2029
Fulfilment indicator	The proposed and selected method of supporting key study programmes at universities under measure 4.3.A will be implemented.

Task 4.3. B	
Budget chapter	MOE

To fulfil the fourth specific objective "By the end of 2026, a system of support for relevant lifelong learning courses (micro certificates) will be designed and implemented", two measures are proposed to support relevant lifelong learning courses (micro certificates). The first measure aims at designing support for lifelong learning courses (micro-certificates). The MoEYS is responsible for the implementation of the measure.

Task 4.4. A	
Specific objective	By the end of 2026, a system of support for relevant lifelong learning courses (culminating in micro-certificates) in the technology sector will be designed and implemented.
Objective of the measure	Increase accessibility and availability of lifelong learning courses in relevant areas.
Description of measures	Designing relevant lifelong learning courses.
Responsibility	Universities
Collaboration	Industrial partners
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	At no additional cost to the state budget.
Benefits	Enhancing the competences of existing staff. Increase the number of job seekers in the technology sector.
Implementation time	2nd half of 2024 to end of 2024
Fulfilment indicator	Material will be produced proposing a system of support for relevant lifelong learning courses.

The second measure aims at the actual implementation of the measures proposed in Task 4.4.A. The MoEYS is responsible for implementation.

Task 4.4.B	
Specific objective	By the end of 2026, a system of support for relevant lifelong learning courses (culminating in micro-certificates) in the technology sector will be designed and implemented.
Objective of the measure	To implement, according to the requirements of industrial partners, lifelong learning courses ending with micro certificates in the technology sector.

Task 4.4.B	
Description of measures	Universities will develop a system of lifelong learning courses to increase the competences of students, graduates and staff in key areas
Responsibility	Universities
Collaboration	Industrial partners, Ministry of Education and Science and MIT
Dependence on the measure	On task 4.4. A
Date of introduction	By the end of 2025
Cost	No additional cost to the state budget. (Courses should be paid for by the sponsor.)
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	2nd half of 2026 to end of 2029
Fulfilment indicator	The proposed system of support for relevant lifelong learning courses under measure 4.4.A will be implemented.

In order to fulfil the fifth specific objective "By the end of 2027, a system for promoting relevant fields of study with the possibility of studying in AJ to potential foreign applicants will be designed and implemented." Two measures are proposed to promote relevant fields of study with the possibility of studying in AJ for potential applicants from abroad. The first measure is aimed at designing a system for the promotion of relevant fields of study in AJ abroad. The MoEYS is responsible for the implementation of the measure.

Task 4.5. A	
Specific objective	By the end of 2027, a system of promotion of relevant study programmes with the possibility of studying in foreign and Czech languages for potential applicants from abroad will be designed and implemented.
Objective of the measure	Propose a system for promoting relevant study programmes to potential foreign applicants.
Description of measures	Given the potential of the Czech labour market, it is also necessary to reach out to students from abroad. Therefore, it is also necessary to focus on regions outside the Czech and Slovak Republics where there is potential to attract applicants to study in the Czech Republic. To this end, a strategy for promoting these programmes abroad will be defined.
Responsibility	MOE
Collaboration	MIT, universities, MFA and embassies of the Czech Republic abroad.
Dependence on the measure	Not
Date of introduction	By the end of 2025

Task 4.5. A	
Cost	350 thousand CZK
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	1st half 2025 to end 2025
Fulfilment indicator	A material will be created with a proposal for a system of promotion of relevant study programmes for potential applicants from abroad.
Budget chapter	MOE

The second measure focuses on the implementation of the proposed system of promotion of relevant fields of study with the possibility of studying in AJ abroad. The MoEYS is responsible for the implementation of the measure.

Task 4.5.B	
Specific objective	By the end of 2027, a system of promotion of relevant study programmes with the possibility of studying in foreign and Czech languages for potential applicants from abroad will be designed and implemented.
Objective of the measure	To implement a system of promotion of relevant fields of study in the Czech Republic for potential applicants from abroad.
Description of measures	Given the potential of the Czech labour market, it is also necessary to reach out to students from abroad. Therefore, it is also necessary to focus on regions outside the Czech Republic and Slovakia, where there is potential to attract applicants to study in both Czech and English language study programmes. Therefore, a strategy to promote these programmes abroad will be implemented. The inclusion of the MoEYS in PROPED is a prerequisite for the implementation of the objective of the measure.
Responsibility	MFA
Collaboration	MIT, Ministry of Education and Science and Universities
Dependence on the measure	On task 4.5. A
Date of introduction	By the end of 2026
Cost	15 million CZK
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	1st half of 2026 to end of 2026
Fulfilment indicator	The proposed system of promotion of relevant fields of study with the possibility of studying in AJ for potential candidates from abroad will be implemented using the PROPED tool under measure 4.5. A.
Budget chapter	MFA

Under the sixth specific objective "By the end of 2029, 2,000 new qualified foreign professionals will work in the semiconductor sector in the Czech Republic." Three measures are defined. The first measure is aimed at strengthening the Czech Republic's embassies in selected target countries. The Ministry of Foreign Affairs of the Czech Republic is responsible for this measure.

Task 4.6.A	
Specific objective	By the end of 2029, 2,000 new qualified foreign professionals will be working in the semiconductor sector in the Czech Republic.
Objective of the measure	Increase capacity to process applications for long-term student stays and dual cards for highly skilled workers in selected target countries.
Description of measures	Given the intention to attract a greater number of highly qualified staff from abroad, it is necessary to strengthen the staff of the Ministry of Foreign Affairs of the Czech Republic in selected countries.
Responsibility	MFA
Collaboration	MV
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	CZK 20 million (CZK 5 million per year) - includes operating and salary expenses for 4 systematised posts necessary to strengthen the MFA's workplaces.
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	From the beginning of 2026
Fulfilment indicator	Capacity will be increased to process applications for long-term student stays and dual cards for highly skilled workers in selected target countries.
Budget chapter	MFA

The second measure is aimed at strengthening the Department of European and International Law of the Ministry of Industry and Trade of the Czech Republic, which processes applications in government economic migration programmes. The Ministry of Industry and Trade of the Czech Republic is responsible for the implementation of the measure.

Task 4.6. B	
Specific objective	By the end of 2029, 2,000 new qualified foreign professionals will be working in the semiconductor sector in the Czech Republic.
Objective of the measure	Increase government capacity to process applications in government economic migration programmes. Particularly in the Key Personnel and Scientific Personnel programs along with the government's Highly Skilled Worker program.

Task 4.6. B	
Description of measures	In view of the intention to attract a higher number of highly qualified foreign workers, it is necessary to strengthen the staff of the Department of European and International Law of the Ministry of Industry and Trade of the Czech Republic.
Responsibility	MIT
Collaboration	Ministry of the Interior and Ministry of Foreign Affairs
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	CZK 3.2 million (CZK 800,000 per year) - includes operating and salary expenses for one systematised post in the Department of European and International Law.
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	From the beginning of 2026
Fulfilment indicator	Capacity to process applications in government economic migration programmes will be increased.
Budget chapter	MIT

The third measure is aimed at strengthening the Department of Asylum and Migration Policy of the Ministry of the Interior of the Czech Republic, which decides on applications for residence for qualified foreign professionals. The Ministry of the Interior of the Czech Republic is responsible for the implementation of the measure.

Task 4.6.C	
Specific objective	By the end of 2029, 2,000 new qualified foreign professionals will be working in the semiconductor sector in the Czech Republic.
Objective of the measure	Increase the capacity to process applications for long-term student stays and employment cards for highly qualified employees from selected target countries.
Description of measures	In view of the intention to attract a higher number of highly qualified workers from abroad, it is necessary to strengthen the staff of the Asylum and Migration Policy Department of the Ministry of the Interior of the Czech Republic for the purpose of deciding on applications for residence of these workers.
Responsibility	MV
Collaboration	MFA and MIT
Dependence on the measure	Not
Date of introduction	By the end of 2025

Task 4.6.C	
Cost	CZK 12.8 million (CZK 3.2 million per year) -The grant is linked to 4 systemised posts necessary to ensure the operation of the MV workplace.
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	From the beginning of 2026
Fulfilment indicator	Capacity will be increased to process applications for long-term student stays and employment cards for highly qualified employees from selected target countries.
Budget chapter	MV

Specific objective 7 "By 2026, highly qualified professionals will be able to communicate with the Czech state administration in English." will be fulfilled by one measure aimed at strengthening the competences of the Asylum and Migration Policy Department. The Ministry of the Interior of the Czech Republic is responsible for the implementation of the first measure.

Task 4.7. A	
Specific objective	By 2026, foreign highly qualified experts will be able to communicate with the Czech immigration service in English in matters of residence in the Czech Republic.
Objective of the measure	Establish an office of the Asylum and Migration Policy Department of the Ministry of the Interior, or expand the existing one, which would allow foreign highly qualified personnel to communicate with this state body in English.
Description of measures	Considering the potential of the Czech labour market, it is also necessary to address highly qualified foreign workers. It would be highly desirable for them to be able to communicate with the Czech immigration service in English and to a greater extent digitally.
Responsibility	MV
Collaboration	-
Dependence on the measure	Not
Date of introduction	By the end of 2025
Cost	CZK 80 million (CZK 20 million per year) - the agenda is linked to 10 systemised posts necessary to ensure the operation of the Ministry of Interior's workplace
Benefits	Increase the number of job seekers in the technology sector.
Implementation time	From the beginning of 2026
Fulfilment indicator	A specialised unit of the Asylum and Migration Policy Department of the Ministry of the Interior will be set up, or the existing unit will be expanded to allow foreign highly qualified personnel to communicate with this state body in English.
Budget chapter	MV

Strategic Goal 5: By the end of 2029, sales of semiconductor companies in the Czech Republic will increase by at least 300% compared to 2022

Five specific objectives and eight actions are proposed under Strategic Objective 5. The first measure (Task 5.1.A) focuses on the implementation of specific objective 5.1: "By the end of 2024, a working group will be established at CzechInvest to evaluate opportunities in the field of semiconductor technologies." CzechInvest is responsible for the implementation of the task.

Task 5.1. A	
Specific objective	By the end of 2024, a working group will be established at CzechInvest to evaluate foreign opportunities in the field of semiconductor technologies.
Objective of the measure	Support the expert capacity of the public administration by establishing a working group with an advisory voice.
Description of measures	The working group will: - monitor developments in the semiconductor sector and evaluate the entry of potential foreign investors into the Czech Republic; - cooperate with CzechInvest in approaching potential investors; - create opportunities for Czech entities abroad.
Responsibility	CzechInvest
Collaboration	MIT and CzechTrade
Dependence on the measure	Not
Date of introduction	From the second half of 2024
Cost	CZK 1.65 million (CZK 300,000 per year for 5.5 years)
Benefits	Strengthening the professional capacity and knowledge of the Czech state administration.
Implementation time	From the second half of 2025
Fulfilment indicator	A working group will be set up.
Budget chapter	CzechInvest

Second specific objective "By the end of 2029, 6 new companies will be established in the Czech Republic in the semiconductor sector." is supported by one measure (Task 5.2.A), which is aimed at extending support to start-up companies in the form of incubator. The CzechInvest agency is responsible for the implementation of the task.

Task 5.2. A	
Specific objective	By the end of 2029, 6 new funded companies will be established in the Czech Republic in the semiconductor sector.
Objective of the measure	Support the creation of new semiconductor companies through an incubation programme.
Description of measures	CzechInvest should continue with the Technology Incubation programme, which runs from 2022 and supports the creation of companies in the fields of AI, Tech for Life, advanced materials, modern transport and creative industries.
Responsibility	CzechInvest
Collaboration	MIT, regional innovation centres and academic institutions
Dependence on the measure	Not
Date of introduction	2025
Cost	250 million CZK (50 million CZK per year)
Benefits	Supporting start-up companies with higher growth potential.
Implementation time	From the second half of 2025
Fulfilment indicator	The Technology Incubation Programme will be extended.
Budget chapter	CzechInvest

The third specific objective "By the end of 2024, complete and launch a programme for the development of Czech suppliers to the semiconductor sector" is supported by one measure. Task 5.3.A is aimed at developing and launching a programme for the development of Czech suppliers, especially SMEs. The CzechInvest agency is responsible for the implementation of the task.

Task 5.3. A	
Specific objective	By the end of 2024, complete and launch a programme for the development of Czech suppliers to the semiconductor sector.
Objective of the measure	Creation and launch of a programme for the development of Czech suppliers (mainly SMEs) in the semiconductor sector to meet the requirements of existing manufacturing companies in the Czech Republic and neighbouring countries.
Description of measures	To build a follow-up programme to the Czech Subcontractors Development Programme, which was implemented by CzechInvest in 2000-2008 and through which almost 150 Czech subcontractors (mainly SMEs) won contracts from existing and incoming foreign investors in the total amount of approximately CZK 7 billion. This will support the expansion of existing companies in the semiconductor industry, the

Task 5.3. A	
	arrival of new companies to the Czech Republic, and the ability of Czech suppliers to supply new plants being built in neighbouring countries.
Responsibility	CzechInvest
Collaboration	MIT and CzechTrade
Dependence on the measure	Not
Date of introduction	By the end of 2024
Cost	20 million CZK (4 million CZK per year)
Benefits	Supporting the expansion of development and production in existing companies in the Czech Republic, supporting the arrival of new investors in the semiconductor industry, supporting exports of high-tech products.
Implementation time	From the end of 2024 to the end of 2029
Fulfilment indicator	A programme for the development of Czech suppliers to the semiconductor sector will be created and launched.
Budget chapter	CzechInvest

The fourth specific objective, "By the end of 2024, start supporting notified projects under the approved IPCEI for microelectronics and communication technologies", is fulfilled by four measures. Task 5.4.A aims to evaluate the call. The MIT is responsible for the implementation of the measure.

Task 5.4. A	
Specific objective	Start supporting notified projects under the approved IPCEI for microelectronics and communication technologies by the end of 2024.
Objective of the measure	Evaluate the IPCEI call for microelectronics and communication technologies.
Description of measures	Applications for support can be submitted until 15 March 2024. Once submitted, applications need to be assessed and evaluated.
Responsibility	MIT
Collaboration	Not
Dependence on the measure	Not
Date of introduction	By the end of 2024

Task 5.4. A	
Cost	No additional cost on the expenditure side of the budget.
Benefits	Support for the development of new innovative products with higher added value.
Implementation time	From the first half of 2024 to the end of 2024
Fulfilment indicator	Notified projects under the approved IPCEI for microelectronics and communication technologies will be supported.

Task 5.4.B is then linked to Task 5.4.A. It aims to initiate the funding of successful projects. The MIT is responsible for the implementation of the task.

Task 5.4. B	
Specific objective	Start supporting notified projects under the approved IPCEI for microelectronics and communication technologies by the end of 2024.
Objective of the measure	To fund successful applicants for IPCEI microelectronics and communications technology projects.
Description of measures	Financing of successful applicants for support for the development of new innovative products with higher added value according to the call implemented in the first half of 2024 on the basis of the National Recovery Plan, component 1.5.1.4.
Responsibility	MIT
Collaboration	Not
Dependence on the measure	On Task 5.4. A
Date of introduction	By the end of 2024
Cost	CZK 1.1 billion (financed by NPO loan)
Benefits	Support for the development of new innovative products with higher added value.
Implementation time	From the second half of 2024 to the end of 2026
Fulfilment indicator	Projects notified under the approved IPCEI for microelectronics and communication technologies will be funded from the National Recovery Plan.

The third measure, Task 5.4.C, addresses the need to fund the follow-up phase of IPCEI Microelectronics II projects (first industrial deployment). The MIT is responsible for the implementation of the task.

Task 5.4.C	
Specific objective	Start supporting notified projects under the approved IPCEI for microelectronics and communication technologies by the end of 2024.

Task 5.4.C	
Objective of the measure	By the end of 2025, secure funding for the follow-up phase of the first industrial exploitation of Czech IPCEI projects in the field of microelectronics and communication technologies (IPCEI ME/CT).
Description of measures	After the completion of the R&D&I phase, which will last until 2026, it will be necessary to secure approx. CZK 400 for the implementation of the first industrial exploitation phase of IPCEI ME/CT projects, which follows the R&D phase and which was supported by the National Recovery Plan.
Responsibility	MIT
Collaboration	ÚV/RVVI
Dependence on the measure	On Task 5.4. B
Date of introduction	2026
Cost	No additional budgetary requirements on the expenditure side of the budget.
Benefits	Involvement in and completion of European projects, including the advantage of the spill-over effect.
Implementation time	From 2026 to the end of 2028
Fulfilment indicator	Funds will be secured for the follow-up phase of the first industrial exploitation of Czech IPCEI projects in the field of microelectronics and communication technologies (IPCEI ME/CT).

The fourth measure (Task 5.4.D) is already aimed at launching the call itself in the framework of innovation support. The MIT is responsible for the implementation of the task.

Task 5.4. D	
Specific objective	Start supporting notified projects under the approved IPCEI for microelectronics and communication technologies by the end of 2024.
Objective of the measure	By the end of 2026, launch a public call for First Industrial Deployment (FID phase) for IPCEI notified projects in the field of Microelectronics and Communication Technologies (IPCEI ME/CT).
Description of measures	This is support for the follow-up phase of IPCEI projects, which is aimed at the first industrial deployment of the technologies developed in the research phase of IPCEI projects.
Responsibility	MIT
Collaboration	Not
Dependence on the measure	On task 5.4.C

Task 5.4. D	
Date of introduction	2026
Cost	Approximately CZK 400 million over the implementation period (approximately CZK 200 million per year)
Benefits	Involvement in and completion of European projects, including the advantage of the spill-over effect.
Implementation time	From 2026 to the end of 2028
Fulfilment indicator	A call for tenders (call) will be launched to support the first industrial deployment (FID phase) for IPCEI notified projects in the field of microelectronics and communication technologies (IPCEI ME/CT).
Budget chapter	MIT

Under the specific objective "By the end of 2024, launch a programme to support the development of regional ecosystems for the semiconductor sector in selected regions of the Czech Republic with lower economic performance." One measure has been proposed to support the development of regional ecosystems for the semiconductor sector in selected regions of the Czech Republic. The CzechInvest agency is responsible for the implementation of the measure.

Task 5.5.A	
Specific objective	By the end of 2024, launch a programme to support the development of regional ecosystems for the semiconductor sector in selected regions of the Czech Republic with lower economic performance.
Objective of the measure	Support the creation and development of regional ecosystems for the semiconductor sector in relevant regions of the Czech Republic.
Description of measures	Implementation of events and missions of representatives of Czech regions, universities and research organizations, industrial clusters or associations and relevant ministries to regional ecosystems for the semiconductor industry in selected regions in Europe, USA and Taiwan, in order to gain know-how in building ecosystems favourable for the development of the semiconductor sector in the region - human resources development, support for innovation, involvement of local companies, infrastructure development, etc.
Responsibility	CzechInvest
Collaboration	MIT and MFA (specifically embassies in target countries)
Dependence on the measure	Not
Date of introduction	By the end of 2024
Cost	1 million CZK (average 333 thousand per year)
Benefits	Building regional ecosystems favourable to the development of the semiconductor sector in selected regions of the Czech Republic, through the implementation of

Task 5.5.A	
	specific actions in areas such as human resources development or support for research, development and innovation. Increasing the attractiveness of these regions and the Czech Republic as a whole for new investments and the development of existing businesses. The measure also has the added value of promoting the Czech Republic and its semiconductor ecosystem abroad.
Implementation time	From the second half of 2024 to the end of 2026
Fulfilment indicator	At least three missions of representatives of Czech regions, universities and research organisations, industry clusters or associations and relevant ministries to regional ecosystems for the semiconductor industry in selected regions in Europe, USA and Taiwan will be carried out.
Budget chapter	CzechInvest

Risk Management

This chapter deals with the identification of the risks that threaten the achievement of the objectives of the National Semiconductor Strategy and how to mitigate them.

Risk analysis

Table 4 represents a risk matrix that captures the identified risks along with an assessment of their impact and likelihood of occurrence.

Table 4: Risk table (own)

	Lower (1)	Level of severity	Higher (3)
Higher (3)	Turnover of responsible staff	Change in market development	Insufficient financial allocation for the implementation of measures
Probability of occurrence	Rigidity of the education system	Dependence on investment projects acquired	Changing policy priorities and objectives
Lower (1)	Lack of information inputs	Setting low ambition measures to meet targets	Insufficient absorption capacity of the sector

Identification of critical risks

Insufficient financial allocation for the implementation of measures, changes in market developments and changes in policy priorities and objectives were identified as critical risks. Insufficient financial allocation for the implementation of measures was identified as the most critical risk with a higher disruptive character (3) and higher probability of occurrence (3). The risk with a higher disruptive character (3) and a medium level of likelihood of occurrence (2) is change in policy priorities and objectives. The risk with a higher likelihood of occurrence (3) and a medium level of severity (2) was identified as change in market developments.

Identification of medium risks

Medium risks are considered to be turnover of responsible staff, lack of absorption capacity in the sector and dependence on acquired investment projects. Staff turnover was assessed as a risk with a high probability of occurrence (3) but a low impact (1). Dependence on investment projects received has a medium impact severity (2) and probability of occurrence (2). Lack of absorptive capacity was rated as a risk with a lower probability of occurrence (1) and medium severity (2).

Identification of moderate risks

Rigidity of the education system, setting low ambition targets and lack of information inputs were identified as moderate risks. Rigidity of the education system was considered a risk with a medium probability of occurrence (2) and a lower level of severity (1). Setting low ambition targets was rated as a risk with a medium level of severity (2) and a lower probability of occurrence (2). Lack of information input is considered a risk with a lower level of severity (1) and probability of occurrence (1).

Risk Mitigation

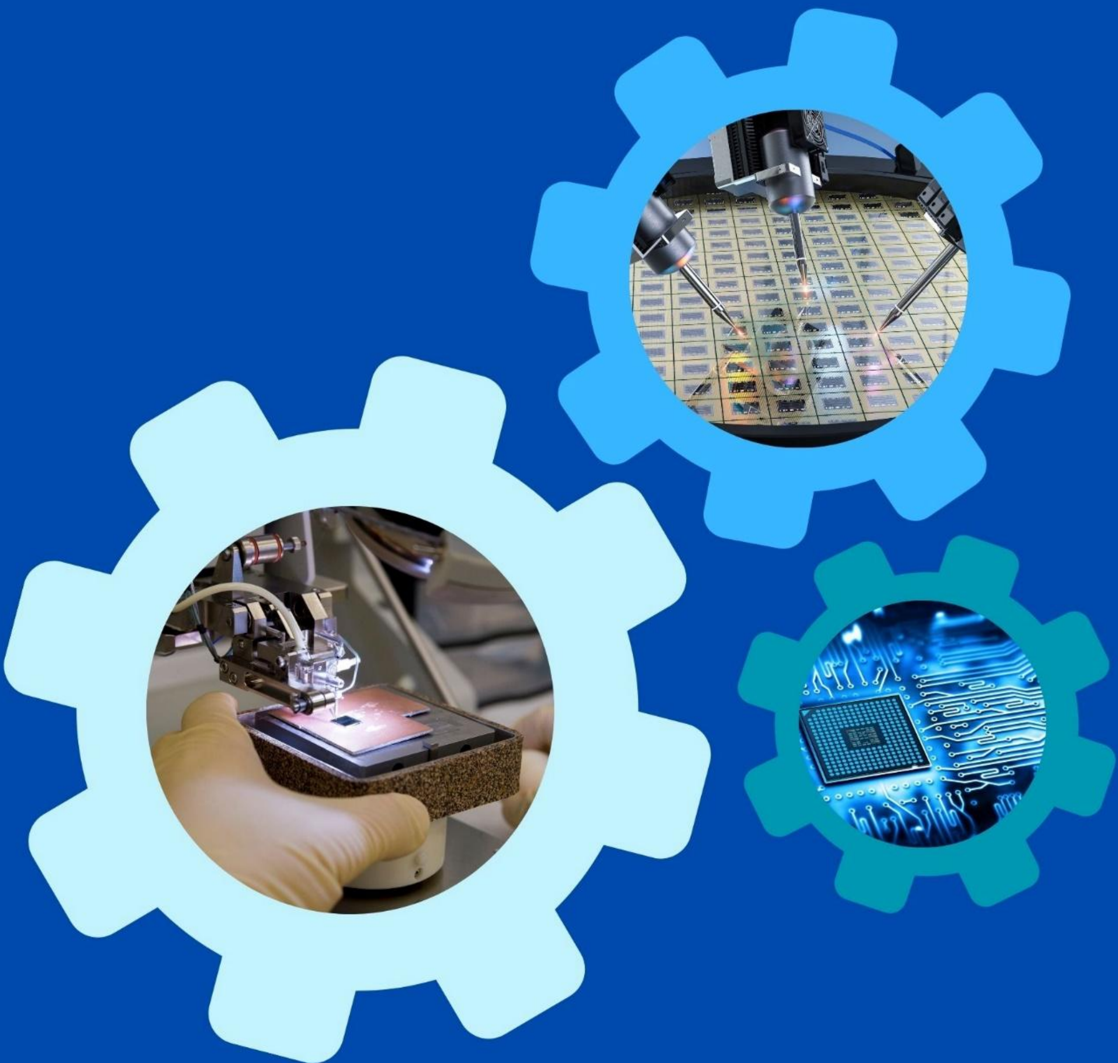
This chapter describes possible activities and measures to mitigate the risks defined in the previous chapter. The risk mitigation is presented in the form of Table 5.

Table 5: Mitigation of identified risks (own)

Risk	Impact	Measures to reduce the impact
Insufficient financial allocation for the implementation of measures	9	Political support needs to be found for the implementation of the strategy, including the measures defined and their impacts.
Change in market development	6	To continuously analyse the market and update the strategy with new market realities, if necessary.
Changing policy priorities and objectives	6	Discuss the strategy also with representatives of the opposition and try to find a long-term consensus.
Dependence on investment projects acquired	4	Negotiations with a wider portfolio of potential foreign investors.
Turnover of responsible staff	3	Implementation of a system for collecting information inputs. Training of new staff by outgoing staff.
Insufficient absorption capacity of the sector	3	Preparation of a sectoral analysis.
Rigidity of the education system	2	Creating pilot projects to circumvent rigidities.
Setting low ambition measures to meet targets	2	Data collection and analysis including sector growth forecasting.

Lack of information inputs	1	Active search for new information inputs.

IMPLEMENTATION PART



IMPLEMENTATION PART

This chapter defines and describes the governance structures responsible for implementing the measures of the National Semiconductor Strategy.

Control structures

The development of semiconductor technologies and their introduction into practice is under the responsibility of the Ministry of Industry and Trade of the Czech Republic, which is responsible for the Economic Section, which coordinates relevant activities, prepares updates of the strategy, creates the necessary management structures, cooperates with other organizations, state and local government authorities, the European Commission and monitors developments in the field of semiconductor technologies. It also receives from the Minister of Industry and Trade the tasks, the main objectives, provides regular reports on the implementation of the identified tasks and objectives, the implementation of the semiconductor strategy and submits to him proposals and suggestions in this area.

Semiconductor Strategy Implementation Coordination Group (KS-NPS) - Top Level

The Coordination Group is established by the Ministry of Industry and Trade of the Czech Republic. The chairman is the Minister of Industry and Trade, the vice-chairman is a member of the Government who acts as the chairman of the Council for Research, Development and Innovation, or a representative authorised by him. The Group is further comprised of the Government Commissioner for Resilience and Economic Modernisation, the Minister of Education, Youth and Sports, the Minister responsible for Digitalisation, the Minister of Finance, the Minister of Labour and Social Affairs, the Minister of Regional Development, the Minister of Foreign Affairs. The Coordination Group may invite guests to its meetings. For example, representatives of other administrations, representatives of local authorities, academic institutions and industry partners.

The main tasks of the Coordination Group are:

- Monitoring the achievement of the National Semiconductor Strategy objectives
- Decision to update the National Semiconductor Strategy

Furthermore, the Coordination Group shall, with the relevant public support providers, coordinate the focus of these programmes (other than R&D programmes) so that the respective calls are in line with the objectives set out in the National Semiconductor Strategy. It shall submit regular reports on the implementation of the objectives of the National Semiconductor Strategy to the Government for information every two years after their consideration by the Research, Development and Innovation Council.

The Coordination Group shall meet at least once a year.

Semiconductor Strategy Implementation Coordination Group (KS-NPS-P) - working level

The Semiconductor Coordination Group - Working Group - addresses key areas for the implementation of the National Semiconductor Strategy at expert level. The group is established by the Ministry of Industry and Trade of the Czech Republic. The Group is composed of the Chief Director of the Economy Section of the Ministry of Industry and Trade, the Chief Director of the Digitisation and Innovation Section of the Ministry of Industry and Trade, the Chief Director of the EU Funds Section of the Ministry of Industry and Trade, the Chief Director of the European Union and Foreign Trade Section of the Ministry of Industry and Trade, a Deputy Government Member responsible for R&D at the level of the Chief Director of the Section or Deputy Government Member, the Deputy Government Commissioner for Resilience and Economic Modernisation, a representative of the Ministry of Education, Youth and Sports, a representative of the Minister responsible for digitisation, a representative of the Ministry of Finance, a representative of the Ministry of Labour and Social Affairs, a representative of the Ministry of Regional Development, a representative of CzechInvest, a representative of CzechTrade, a representative of the Technology Agency of the Czech Republic, a representative of the Rectors' Conference, a representative of the Alliance for Electrical Engineering and Informatics and representatives of industrial partners, in particular, but not exclusively, the Czech National Semiconductor Cluster, z. s., The Union of Industry and Transport and the Chamber of Commerce. The group is chaired by a representative of the state administration at the level of the Chief Director of the Section or Deputy Member of the Government, depending on the issue addressed. The Coordination Group may invite guests to its meetings. In particular, the following issues will be addressed at the group:

1. Implementation of the National Semiconductor Strategy - in the case of this area, the Coordination Group is chaired by the Chief Director of the Economic Section of the Ministry of Industry and Trade.
2. Research and development - in the case of this area, the coordination group is chaired by a representative of the member of the Government responsible for research and development at the level of a senior director of a section or a deputy member of the Government.
3. Investments - in the case of this area, the Coordination Group is chaired by the Chief Director of the Digitalisation and Innovation Section of the Ministry of Industry and Trade.
4. Non-investment public support - in the case of this area, the Coordination Group is chaired by the Chief Director of the EU Funds Section of the Ministry of Industry and Trade.
5. Export activities - in the case of this area, the Coordination Group is chaired by the Chief Director of the European Union and Foreign Trade Section of the Ministry of Industry and Trade.
6. Education and Human Resources - in the case of this area, the Coordination Group is chaired by the Chief Director of the Higher Education, Science and Research Section of the Ministry of Education, Youth and Sports.

The main tasks of the working level coordination group are:

- Coordination of the implementation of the National Semiconductor Strategy in the Czech Republic.
- Monitoring the implementation of the objectives of the National Semiconductor Strategy at expert level.
- Draft recommendations to the Summit Coordination Group.
- Proposing new measures needed.
- Sharing relevant information of a cross-departmental nature.
- Coordination of ongoing activities at different levels.

The group meets as needed, but at least once every six months.

Officer in charge of the implementation of the National Semiconductor Strategy

He/she is an employee of the Department of Sectoral Expertise and Industrial Policy of the Ministry of Industry and Trade of the Czech Republic or the Commissioner of the Minister of Industry and Trade for the area of semiconductor technologies, if this post is established. This official will be responsible for managing the implementation of the National Semiconductor Strategy. His/her task is to plan, organise, lead, control and evaluate the implementation of the measures. He/she shall also prepare input to the Coordination Group for the implementation of the Semiconductor Strategy at working and senior level. The incumbent should be at least grade 14.

Measures to implement the strategy's governance structures

For the purpose of managing the implementation of the strategy, the two coordination groups described above need to be established. The first coordination group is the "Semiconductor Strategy Implementation Coordination Group - Top Level". It is the responsibility of the Economic Section of the MIT to set it up.

Measure 1	
Objective of the measure	Establish a top-level Coordination Group for the Implementation of the Semiconductor Strategy (KS-NPS-HL).
Responsibility	MIT - Economic Section
Term of performance	By the end of the second half of 2024
Cost	No additional budgetary requirements on the expenditure side of the budget.

The second coordination group is the "Semiconductor Strategy Implementation Coordination Group - Working Level." The MIT Economic Section is again responsible for its establishment.

Measure 2	
Objective of the measure	Establish a Coordination Group for the Implementation of the Semiconductor Strategy (KS-NPS) at working level.
Responsibility	MIT - Economic Section
Term of performance	By the end of the second half of 2024
Cost	No additional budgetary requirements on the expenditure side of the budget.

Outside of the coordination group, a staff member should be assigned to be responsible for the strategy implementation project.

Measure 3	
Objective of the measure	Designate a staff member to be responsible for the implementation of the National Semiconductor Strategy.
Responsibility	MIT - Economic Section
Term of performance	By the end of the second half of 2024
Cost	No additional budgetary requirements on the expenditure side of the budget.

SOURCES

Alsop Thomas (2024), Semiconductor foundries revenue share worldwide 2019-2023, by quarter. Statista.com, (cited 2024-03-17). Available from: https://www.statista.com/statistics/867223/worldwide-semiconductor-foundries-by-market-share/

Blomberg (2023), Germany Readies €20 Billion in Aid to Bolster Chip Output. (Cited 2024-01-11). Available from: https://www.bloomberg.com/news/articles/2023-07-24/germany-readies-20-billion-in-aid-to-bolster-chip-production

Donga Ilbo (2021), 50% tax deduction for semiconductor R&D expenses... Support for the construction of the largest "K Belt" in the world. (Cited 2024-01-11). Available from: https://www.donga.com/news/Economy/article/all/20210514/106914919/1

European Commission (2018), RE-FINDING INDUSTRY: Report from the High-Level Strategy Group on Industrial Technologies (cited 2023-10-15). Available from: https://ec.europa.eu/docsroom/documents/28102/attachments/1/translations/en/renditions/pdf

European Commission (2022), European Chips Act: Staff Working document. (Cited 2023-10-15). Available from: https://ec.europa.eu/newsroom/dae/redirection/document/86690

GOV.UK (2023), National semiconductor strategy. (Cited 2024-01-26). Available from: https://www.gov.uk/government/publications/national-semiconductor-strategy/national-semiconductor-strategy#executive-summary

Government of the Netherlands (2024), The Netherlands to invest €2.5 billion to strengthen business climate for chip industry in Brain port Eindhoven. (cit. 2024-07-19). Available from: https://www.government.nl/latest/news/2024/03/28/the-netherlands-to-invest-%E2%82%AC2.5-billion-to-strengthen-business-climate-for-chip-industry-in-brainport-eindhoven

MarketsandMarkets (2023), Power Electronics Market. (Cited 2024-03-26). Available from: https://www.marketsandmarkets.com/Market-Reports/power-electronics-market-204729766.html

market.us (2024), Global Semiconductor Market. (dit. 2024-04-10). Available from: https://market.us/report/semiconductor-market/#overview

McKinsey & Company (2024), Exploring new regions: the greenfield opportunity in semiconductors. (Cited 2024-02-01). Available from: https://www.mckinsey.com/industries/semiconductors/our-insights/exploring-new-regions-the-greenfield-opportunity-in-semiconductors?cid=eml-web

METIS (2021), Microelectronics Training, Industry and Skills. (Cited 2024-02-01) Available from: https://www.metis4skills.eu/

Ministry of Industry and Trade of the Czech Republic (MIT, 2021), National Research and Innovation Strategy for Smart Specialization of the Czech Republic 2021-2027 (National RIS3 Strategy) (cited 2023-10-15). Available from: https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/dokumenty/2021/1/A_RIS3-Strategie.pdf

Porsche Consulting (2023), European semiconductor industry - Market overview

PwC (2024), Over PLN 7 billion of support for the semiconductor sector. (Cited 2024-01-11). Available from: https://studio.pwc.pl/aktualnosci/english/insights/over-pln-7-billion-of-support-for-the-semiconductor-sector

Reuters (2022a), Exclusive: China readying $143 billion package for its chip firms in face of U.S. curbs. (Cited 2024-01-11). Available from: https://www.reuters.com/technology/china-plans-over-143-bln-push-boost-domestic-chips-compete-with-us-sources-2022-12-13/

Reuters (2022b), Spain to spend 12.25 bln euros on microchip industry. (cited 2024-01-11). Available from: https://www.reuters.com/markets/europe/spain-spend-1225-bln-euros-microchip-industry-2022-05-24/

Reuters (2023a), Exclusive: China to launch $40 billion state fund to boost chip industry. (Cited 2024-01-11). Available from: https://www.reuters.com/technology/china-launch-new-40-bln-state-fund-boost-chip-industry-sources-say-2023-09-05/

Reuters (2023b), Japan to spend $13 bln for chip industry support in extra budget. (Cited 2024-01-11). Available from: https://www.reuters.com/markets/asia/japan-allocate-13-bln-chip-industry-support-extra-budget-2023-11-10/

Reuters (2023c), Britain's $1.3 billion semiconductor support plan gets cool response. (Cited 2024-01-11). Available from: https://www.reuters.com/world/uk/uk-plans-1-bln-pounds-semiconductor-investment-new-strategy-2023-05-18/

Reuters (2023d), Israel grants Intel $3.2 billion for new $25 billion chip plant. (Cited 2024-01-11). Available from: https://www.reuters.com/technology/intel-get-32-billion-government-grant-new-25-billion-israel-chip-plant-2023-12-26/

Reuters (2023e), France to provide 2.9 billion euros in aid for new Micro/GlobalFoundries factory. (Cited 2024-01-11). Available from: https://www.reuters.com/markets/europe/france-provide-29-bln-euros-aid-new-stmicroglobalfoundries-factory-2023-06-05/

Reuters (2023f), Italy plans measures to support key sectors including microelectronics. (Cited 2024-01-11). Available from: https://www.reuters.com/markets/europe/italy-plans-measures-support-key-sectors-including-microelectronics-2023-08-04/

Semiconductor Industry Association (SIA, 2021), 2021 FACTBOOK. (Cited 2023-12-09). Available from: https://www.semiconductors.org/wp-content/uploads/2021/05/2021-SIA-Factbook-FINAL1.pdf

Semiconductor Industry Association (2022). CHIPS for America Act & FABS Act. (Cited 2023-10-02). Available from: https://www.semiconductors.org/chips/

Statista.com (2024a), Statista Market Insights: Semiconductors. (Cited 2024-07-04). Available from: https://www.statista.com/outlook/tmo/semiconductors/worldwide

Statista.com (2024b), Statista Market Insights: Passenger Cars - Worldwide. (Cited 2024-03-17). Available from: https://www.statista.com/outlook/mmo/passenger-cars/worldwide

Statista.com (2024c), Statista Market Insights: Battery Electric Vehicles - Worldwide. (Cited 2024-03-17). Available from: https://www.statista.com/outlook/mmo/electric-vehicles/battery-electric-vehicles/worldwide

Statista.com (2024d), Statista Market Insights: Plug-in Hybrid Electric Vehicles - Worldwide. (Cited 2024-03-17). Available from: https://www.statista.com/outlook/mmo/electric-vehicles/plug-in-hybrid-electric-vehicles/worldwide

Statista.com (2024e), Statista Market Insights: Energy - Worldwide. (Cited 2024-03-17). Available from: https://www.statista.com/outlook/io/energy/worldwide#production

Statista.com (2024f), Statista Market Insights: Cybersecurity - Worldwide. (Cited 2024-03-17). Available from: https://www.statista.com/outlook/tmo/cybersecurity/worldwide

Statista.com (2024g), Statista Market Insights: Artificial Intelligence - Worldwide. (Cited 2024-03-17). Available from: https://www.statista.com/outlook/tmo/artificial-intelligence/worldwide#market-size

The Diplomat (2023), South Korea's Semiconductor Funds Highlight a Partisan Battle. (Cited 2023-12-07). Available from: https://thediplomat.com/2023/09/south-koreas-semiconductor-funds-highlight-a-partisan-battle/

Yole Intelligence (2023), The trillion-dollar semiconductor industry poised for a new cycle of growth fueled by breakthroughs in AI, quantum computing, 5G, and specialized applications. (Cited 2023-11-27). Available from: https://www.yolegroup.com/product/report/overview-of-the-semiconductor-devices-industry-2023/

World Bank (2023), (cited 2023-12-07). Available from: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?view=map

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MINISTRY OF
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Authors of attachments

Annex 1: Quantification of the additional costs to the state budget

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Annex 2: Production in the Czech Republic

Author's collective led by Stanislav Černý and Patrik Budský

Annex 3: Chip support programmes

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Annex 4: IPCEI Major Projects of Common European Interest

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Annex 9: Analysis of public support for research and development

Patrik Budsky

Annex 1: Quantification of the additional costs to the state budget

Table 1 describes the distribution of the requirements for the co-financing of measures (tasks) from the state budget in individual years. Some of the measures are dependent on political decisions. The IPCEI R&D phase and the TWIST programme are already budgeted.

Table 1: Financing of the strategy by year (own)

Measures	2024	2025	2026	2027	2028	2029
Task 1.1. A						
Task 1.1. B		25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	
Task 1.2.A*						
Task 1.2.B*		50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK
Task 1.2.C*						
Task 1.2.D*			375,00 mil. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK
Task 1.3.A**		33,00 mil. CZK	1 276,00 mil. CZK	2 828,00 mil. CZK	9 863,00 mil. CZK	6 000,00 mil. CZK
Task 1.4. A			0 mil. CZK	0 mil. CZK	0 mil. CZK	0 mil. CZK
Task 1.5. A						
Task 1.5. B		1,00 mil. CZK				
Task 2.1. A	0,03 mil. CZK					
Task 2.2. A	0,03 mil. CZK					
Task 2.3. A	0,03 mil. CZK					
Task 2.4. A		12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK
Task 3.1. A			150,00 mil. CZK	150,00 mil. CZK	150,00 mil. CZK	150.00 miles. CZK
Task 3.2. A		35.50 miles. CZK	101.50 million. CZK	97,00 mil. CZK	51.50 million. CZK	64.50 million. CZK
Task 3.3.A***		50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK
Task 4.1. A						
Task 4.1. B						
Task 4.2. A		0,35 mil. CZK				
Task 4.2. B			25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK
Task 4.3. A		0,35 mil. CZK				
Task 4.3. B			25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK
Task 4.4. A		0,35 mil. CZK				
Task 4.4. B			12.50 miles. CZK	12.50 miles. CZK	12.50 miles. CZK	12.50 miles. CZK
Task 4.5. A			0,35 mil. CZK			
Task 4.5. B			3.75 million. CZK	3.75 million. CZK	3.75 million. CZK	3.75 million. CZK
Task 4.6. A			5,00 mil. CZK	5,00 mil. CZK	5,00 mil. CZK	5,00 mil. CZK
Task 4.6. B			0,80 mil. CZK	0,80 mil. CZK	0,80 mil. CZK	0,80 mil. CZK

Measures	2024	2025	2026	2027	2028	2029
Task 4.6.C			3.20 million. CZK	3.20 million. CZK	3.20 million. CZK	3.20 million. CZK
Task 4.7. A			20.00 miles. CZK	20.00 miles. CZK	20.00 miles. CZK	20.00 miles. CZK
Task 5.1. A	0,15 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	0,30 mil. CZK
Task 5.2. A		50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK
Task 5.3. A		4,00 mil. CZK	4,00 mil. CZK	4,00 mil. CZK	4,00 mil. CZK	4,00 mil. CZK
Task 5.4. A						
Task 5.4.B***	220,00 mil. CZK	440,00 mil. CZK	440,00 mil. CZK			
Task 5.4.C						
Task 5.4. D				200,00 mil. CZK	200,00 mil. CZK	
Task 5.5. A	0,20 mil. CZK	0,40 mil. CZK	0,40 mil. CZK			
Total	220.44 million. CZK	669.75 million. CZK	2 650.10 million. CZK	3 586.35 million. CZK	10 621.35 million. CZK	6 533.35 million. CZK
Total in €	9 million. €	27 miles. €	106 million. €	143 miles. €	425 miles. €	261 miles. €
Without R&D phase of IPCEI	0.44 million. CZK	229.75 million. CZK	2 210.10 million. CZK	3 586.35 million. CZK	10 621.35 million. CZK	6 533.35 million. CZK

* The budgetary impact depends on the government's decision.

** This is the maximum commitment from the existing budget for investment incentives. It does not have to be exhausted.

*** The required funding is already part of the state budget and its medium-term outlook or the National Recovery Plan (NRP)

Table 2 describes the first option (Option I) of the necessary co-financing of the measures from the state budget if the Czech Republic does not want to participate in the pilot lines programme. The calculation excludes funding for investment incentives, the R&D phase of IPCEI and the TWIST programme of targeted support.

Table 2: Option I (own)

Entity	2024	2025	2026	2027	2028	2029
MIT	0,05 mil. CZK	13.00 miles. CZK	12.80 million. CZK	212.80 million. CZK	212.80 million. CZK	12.80 million. CZK
MOE	0,03 mil. CZK	25.70 million. CZK	225.35 million. CZK	225,00 mil. CZK	225,00 mil. CZK	200,00 mil. CZK
CzechInvest	0,35 mil. CZK	54.70 million. CZK	54.70 million. CZK	54.30 million. CZK	54.30 million. CZK	54.30 million. CZK
TA ČR		35.50 miles. CZK	101.50 million. CZK	97,00 mil. CZK	51.50 million. CZK	64.50 million. CZK
MV			23.20 million. CZK	23.20 million. CZK	23.20 million. CZK	23.20 million. CZK
MFA			8.75 million. CZK	8.75 million. CZK	8.75 million. CZK	8.75 million. CZK
MD			0 mil. CZK	0 mil. CZK	0 mil. CZK	0 mil. CZK
Total	0,43 mil. CZK	128.90 million. CZK	426.30 million. CZK	621.05 million. CZK	575.55 million. CZK	363.55 million. CZK
Total €	0 mil. €	5 miles. €	17 miles. €	25 miles. €	23 miles. €	15 miles. €

Table 3 describes the second option (Option II) of the required co-financing of the measures from the state budget for the alternative in which the Czech Republic would like to participate in the pilot lines programme through an existing consortium. The costs are therefore increased by 250 million CZK at the Ministry of Education and Science. The calculation excludes funds for investment incentives, the R&D phase of IPCEI and the dedicated support programme TWIST.

Table 3: Option II (own)

Entity	2024	2025	2026	2027	2028	2029
MIT	0,05 mil. CZK	13.00 miles. CZK	12.80 million. CZK	212.80 million. CZK	212.80 million. CZK	12.80 million. CZK
MOE	0,03 mil. CZK	25.70 million. CZK	275.35 million. CZK	275,00 mil. CZK	275,00 mil. CZK	250.00 miles. CZK
CzechInvest	0,35 mil. CZK	54.70 million. CZK	54.70 million. CZK	54.30 million. CZK	54.30 million. CZK	54.30 million. CZK
TA ČR		35.50 miles. CZK	101.50 million. CZK	97,00 mil. CZK	51.50 million. CZK	64.50 million. CZK
MV			23.20 million. CZK	23.20 million. CZK	23.20 million. CZK	23.20 million. CZK
MFA			8.75 million. CZK	8.75 million. CZK	8.75 million. CZK	8.75 million. CZK
MD			0 mil. CZK	0 mil. CZK	0 mil. CZK	0 mil. CZK
Total	0,43 mil. CZK	178.90 million. CZK	476.30 million. CZK	671.05 million. CZK	625.55 million. CZK	413.55 million. CZK
Total €	0 mil. €	7 million. €	19 miles. €	27 miles. €	25 miles. €	17 miles. €

Table 4 describes the third option (Option III) of the required co-financing of the measures from the state budget for the possibility that the Czech Republic will want to participate in the pilot lines programme by forming its own consortium to apply for the operation of the pilot line. The financial requirements are therefore increased by 450 million CZK in the chapter of the Ministry of Education and Science. The calculation excludes funds for investment incentives, the R&D phase of IPCEI and the dedicated support programme TWIST.

Table 4: Option III (own)

Entity	2024	2025	2026	2027	2028	2029
MIT	**0,05 mil. CZK**	**13.00 miles. CZK**	**12.80 million. CZK**	**212.80 million. CZK**	**212.80 million. CZK**	**12.80 million. CZK**
MOE	**0,03 mil. CZK**	**25.70 million. CZK**	**600.35 million. CZK**	**250.00 miles. CZK**	**250.00 miles. CZK**	**225,00 mil. CZK**
CzechInvest	**0,35 mil. CZK**	**54.70 million. CZK**	**54.70 million. CZK**	**54.30 million. CZK**	**54.30 million. CZK**	**54.30 million. CZK**
TA ČR		**35.50 miles. CZK**	**101.50 million. CZK**	**97,00 mil. CZK**	**51.50 million. CZK**	**64.50 million. CZK**
MV			**23.20 million. CZK**	**23.20 million. CZK**	**23.20 million. CZK**	**23.20 million. CZK**
MFA			**8.75 million. CZK**	**8.75 million. CZK**	**8.75 million. CZK**	**8.75 million. CZK**
MD			**0 mil. CZK**	**0 mil. CZK**	**0 mil. CZK**	**0 mil. CZK**
Total	**0,43 mil. CZK**	**128.90 million. CZK**	**801.30 million. CZK**	**646.05 million. CZK**	**600.55 million. CZK**	**388.55 million. CZK**
Total €	**0 mil. €**	**5 miles. €**	**32 miles. €**	**26 miles. €**	**24 miles. €**	**16 miles. €**

Table 5 describes the fourth option (Option IV) of the required co-financing of the measures from the state budget for the alternative in which the Czech Republic would want to participate in the pilot lines programme both through one of the existing consortia and would want to form its own consortium to apply for the operation of the pilot line. The funding is therefore increased by CZK 700 million in the chapter of the Ministry of Education and Science. The calculation excludes funds for investment incentives, the R&D phase of IPCEI and the TWIST special-purpose support programme.

Table 5: Option IV (own)

Entity	2024	2025	2026	2027	2028	2029
MIT	0,05 mil. CZK	13.00 miles. CZK	12.80 million. CZK	212.80 million. CZK	212.80 million. CZK	12.80 million. CZK
MOE	0,03 mil. CZK	75.70 million. CZK	650.35 million. CZK	300,00 mil. CZK	300,00 mil. CZK	275,00 mil. CZK
CzechInvest	0,35 mil. CZK	54.70 million. CZK	54.70 million. CZK	54.30 million. CZK	54.30 million. CZK	54.30 million. CZK
TA ČR		35.50 miles. CZK	101.50 million. CZK	97,00 mil. CZK	51.50 million. CZK	64.50 million. CZK
MV			23.20 million. CZK	23.20 million. CZK	23.20 million. CZK	23.20 million. CZK
MFA			8.75 million. CZK	8.75 million. CZK	8.75 million. CZK	8.75 million. CZK
MD			0 mil. CZK	0 mil. CZK	0 mil. CZK	0 mil. CZK
Total	0,43 mil. CZK	178.90 million. CZK	851.30 million. CZK	696.05 million. CZK	650.55 million. CZK	438.55 million. CZK
Total €	0 mil. €	7 million. €	34 miles. €	28 miles. €	26 miles. €	18 miles. €

Table 6 describes the total cost of the different options presented. Excluded from the calculation are funds for investment incentives, the R&D phase of IPCEI and the dedicated support programme TWIST. The investment incentives are very likely to be strategic investment actions to be decided by the government. The R&D phase of IPCEI and the TWIST programme of targeted support are already included in the State budget and its medium-term outlook and are therefore not included in the quantification of the additional costs to the State budget.

Table 6: Total additional funding requirements from the state budget (own)

Entity	Total Option I	Total variant II	Total variant III	Total Option IV
MIT	464.25 million. CZK	464.25 million. CZK	464.25 million. CZK	464.25 million. CZK
MOE	900.08 million. CZK	1 151.08 million. CZK	1 351.08 million. CZK	1 601.08 million. CZK
CzechInvest	272.65 million. CZK	272.65 million. CZK	272.65 million. CZK	272.65 million. CZK
TA ČR	350.00 miles. CZK	350.00 miles. CZK	350.00 miles. CZK	350.00 miles. CZK
MV	92.80 million. CZK	92.80 million. CZK	92.80 million. CZK	92.80 million. CZK
MFA	35,00 mil. CZK	35,00 mil. CZK	35,00 mil. CZK	35,00 mil. CZK
MD	0,00 mil. CZK	0,00 mil. CZK	0,00 mil. CZK	0,00 mil. CZK
Total	2 115.78 million. CZK	2 365.78 million. CZK	2 565.78 million. CZK	2 815.78 million. CZK
Total €	85 miles. €	95 miles. €	103 miles. €	113 miles. €

Table 7: State budget revenue and expenditure for Option I - nominal (own)

Option I	2024	2025	2026	2027	2028	2029	2030	2031
Corporate income tax	0,00 CZK	0,00 CZK	CZK 10 007 179,59	CZK 13 089 674,96	21 392 250,91 CZK	37 495 782,23 CZK	CZK 53 090 749,26	CZK 55 374 498,92
Social contributions	0,00 CZK	91 076 370,70 CZK	211 127 573,11 CZK	391 813 170,00 CZK	CZK 639 691 532,15	CZK 962 985 813,46	CZK 1 015 595 502,96	0,00 CZK
Personal income tax	0,00 CZK	0,00 CZK	22 378 016,57 CZK	CZK 52 424 748,42	98 257 598,75 CZK	161 896 918,11 CZK	245 841 198,23 CZK	261 059 598,30 CZK
Total state budget revenue	**0,00 CZK**	**91 076 370,70 CZK**	**CZK 243 512 769,27**	**457 327 593,39 CZK**	**759 341 381,81 CZK**	**CZK 1 162 378 513,79**	**CZK 1 314 527 450,45**	**CZK 316 434 097,23**
Total costs Option I	**220 425 000,00 CZK**	**618 900 000,00 CZK**	**916 300 000,00 CZK**	**CZK 671 050 000,00**	**625 550 000,00 CZK**	**CZK 413 550 000,00**	**0,00 CZK**	**0,00 CZK**

Table 7 shows nominal values, thus describing the scenario unencumbered by discounting to present value, assuming the fulfilment of Option I.

Annex 2: Production in the Czech Republic

On the basis of analyses of the financial statements, it was found that in 2022, the Czech Republic employed about 1,000 people in the integrated circuit design sector and the sector had a turnover of about CZK 1.4 billion. The integrated circuit manufacturing sector employed approximately 2 000 people and had a turnover of approximately CZK 7,3 billion. Overall, this sector employs about 3 000 people directly in the Czech Republic and generates sales of CZK 8,7 billion.

Production

In the Czech Republic, we have three chip (integrated circuit) factories.

- ON SEMICONDUCTOR CZECH REPUBLIC, s.r.o. (parent company of onsemi, USA) in Rožnov produces semiconductor polished and epitaxial wafers and semiconductor chips. The company follows the tradition of TESLA (founded in Rožnov in 1949) and after its dissolution (1993), two of the successor companies (TEROSIL and TESLA SEZAM) became part of MOTOROLA Corporation, from which the division of standard semiconductor products - ON Semiconductor - was spun off in 1999, from 2022 - onsemi (NASDAQ: ON, www.onsemi.com). ON SEMICONDUCTOR CZECH REPUBLIC had sales of CZK 4.8 billion in 2022 and employed 1,700 people. The company manufactures power semiconductor components for the automotive, military and aerospace industries, medical devices, communications and consumer electronics. In the Czech Republic, the company has two sister companies engaged in the design of new semiconductor components: the SCG Czech Design Center (Rožnov p. R.) and ON Design Czech (Brno).
- Hitachi Energy Czech Republic s.r.o. (Hitachi, Japan) has a small factory in Prague for the production of welding diodes for automotive, conventional and switching thyristors, transistors and fast diodes (Power Electronics) for power converters for rail vehicles, wind power plants, power transmission and industry. These include inverters for High-Voltage Direct Current (HVDC) power transmission systems, particularly for renewable energy transmission. The company follows the tradition of ČKD Polovodiče, later Polovodiče a.s., taken over by ABB, in the later restructuring of ABB transferred to Hitachi Energy. Hitachi employs around 250 people in the production of discrete semiconductors and generates sales of approximately 2.5 billion.
- The laser diodes were intended to be manufactured in Kralupy nad Vltavou by Astrum LT (Lithuania), which is owned by the Russian company Melsystech. However, the owners are on the sanctions list and production has not yet started.

Integrated circuit designs

- onsemi has two centres in the Czech Republic, which focus on the design of new semiconductor components.
  - ON Design Czech, s.r.o. (sister company ON SEMICONDUCTOR CZECH REPUBLIC, s.r.o.) - development and design of integrated circuits. It employs 160 people. Revenues CZK 250 million. The company is based in Brno.
  - SCG Czech Design Center, s.r.o. (sister company of ON SEMICONDUCTOR CZECH REPUBLIC, s.r.o.) - development and design of integrated circuits for the parent company. It employs 312 people. Revenues CZK 550 million. The company is based in Rožnov.
  - Both companies design integrated circuits in Rožnov and Brno (about 200 specialists in total). They also develop software for large data processing and production automation. About 100 specialists work in IT.
- STMicroelectronics Design and Application s.r.o. is a subsidiary of the French-Italian company STMicroelectronics N.V., which is Europe's largest chip manufacturer. STMicro already has a roughly

two-strong development centre in Prague, which is expected to grow further. STMicro had sales of around CZK 350 million in the Czech Republic in 2021.

- Renesas Design Czech s.r.o. is a branch of the Japanese company Renesas. The company is primarily engaged in the design of complex chips for industry and industrial IoT devices, complex SoC architectures integrating analogue and digital subsystems, power management, etc. Their integrated circuits use various CPU architectures and are implemented in technologies ranging from 180 nm to 12 nm FinFet. Renesas offers its chip design expertise to customers primarily in Europe and North America. In 2022, the company had 41 employees and revenues in excess of 100 million kronor.
- ASICentrum has "the know-how to design and manufacture ultra-low power and low voltage circuits for use in battery-powered portable devices. These technologies are used for the development and production of a wide range of products, including for example wireless transmission (RFID, Bluetooth) or smart sensors (optical, motion, magnetic) and for consumer, industrial and automotive applications. The company employs 63 people and generates sales of CZK 127 million.
- Tropic Square is a Czech start-up developing a chip on the RISC-V instruction set, which it wants to make the standard in hardware wallet security. The chip is manufactured using a 55nm process at UMC in Taiwan.
- Codasip is a start-up owned by a German mother with Czech capital in an advanced stage of growth (it already has over 220 employees, of which approximately 100 are in the Czech Republic). It develops both an automation tool (Automatic Design Automation - EDA) for processor design and its own processor cores (CPU, MCU, ECU) based on the open standard RISC-V, which can be seen as an alternative to ARM. The company is active in several segments such as cybersecurity, automotive, Artificial Intelligence (AI/ML) or High-Performance Computing (HPC), where in many cases it leads or co-leads the design of test chips, whether with established technologies such as 22nm or more advanced ones such as 7nm, both from Taiwan's TSMC, with the Belgian company IMEC being Codasip's design partner.
- In 2020, Intel bought its P4 technology, developed in cooperation with CESNET and the Faculty of Information Technology of the Brno University of Technology with the support of public funds, from Netcope (now MAGMIO a.s.). The Netcope P4 is a cloud-based platform that enables so-called packet processing pipelines for field programmable gate arrays (FPGAs). Intel is further expanding research and development in Brno on this basis. Brno is one of the investments in Central and Eastern Europe for the American giant. Others are in Poland and especially in eastern Germany.
- Magmio a.s. is now engaged in accelerating electronic trading on the stock exchange using FPGAs. In 2022, it had approximately 13 employees and sales of 32.8 million CZK. The company is owned by Czech capital, according to the beneficial owners' records.
- CESNET is continuing similar activities it had with the original Netcope. In February 2022, CES completed a 400 Gbps FPGA accelerator network card with French company Reflex CES. This is one of the first products of its kind in the world. The French will sell the Brno technology under their own brand, while the Czech company BrnoLogic will provide the FPGA chip designs.
- Brno logic is a Czech start-up engaged in development, consulting and training related to programmable logic technology, especially FPGA and ASIC. Initially, the founders were involved in the development of FPGA accelerator network cards.
- In close cooperation with Evolving Systems Consulting, On Semiconductor and CTU, UJP Prague forms a group of more than 40 specialists dedicated to the design of custom radiation-hardened chips suitable for applications in healthcare, space industry, environment, radiation protection, nuclear energy or research centers.
- ADVACAM s.r.o. is one of the main players in the field of display chips, which are different from traditional computing chips such as processors in mobile phones or computers. They work like

sensors. They have pixels that can capture and count photons of many types of incident radiation and determine its energy and direction. This can measure many different quantities, including radioactivity or cosmic rays. The company is working with Charles University (MFF UK) to produce high-efficiency semiconductor detectors.

- Analog Bits, Inc. is a spin-off of Analog Bits, Inc., an American company that was acquired by South Korean start-up SemiFive in 2022. Analog Bits develops analogue and mix signal building blocks (libraries and other IP). The plant was founded in late 2023 by researchers from FJFI CTU. Analog Bits presents it on its website as "Prague Design Center".

Software solutions

- NXP Semiconductors Czech Republic s.r.o. is a branch of a Dutch company based in Rožnov pod Radhoštěm. NXP employs over 500 people in the Czech Republic and the sales of the branch in 2022 amounted to more than 600 million crowns. The company's activities include software development for NXP microcontrollers and customer support. NXP's development centre works on the design of state-of-the-art software technologies key to microcontroller deployment. Technologies under development include motor control, wireless charging, communications in embedded systems, embedded operating systems, embedded software development and productization for automotive and industrial applications, image processing algorithm development, machine learning algorithm development, software development and tools for safety and security. In addition to SW development, the teams are involved in the design and validation of new microcontrollers.
- Inference Tech, s.r.o. is a Czech company providing software for analysis and prediction of front-end part of integrated circuit production.
- Broadcom has one of the largest software development hubs in Prague. According to job offers, it is a development center focused on development for mainframe computers and software product development

Suppliers

- Meopta, owned by a foreign investment fund through a Luxembourg company, has a division focused on the semiconductor sector and develops highly sophisticated optics used, for example, in machines for chip production. A major customer of optics from Prerov is the Dutch icon ASML, the only company in the world that can supply lithography machines with EUV. MEOPTA also supplies very demanding subassemblies for manufacturers of chip inspection equipment, including the American companies AMAT and KLA.
- Thermo Fisher Scientific and Delong Instruments are Brno-based companies that produce electron microscopes used for visual and analytical inspection of chips, defect analysis in semiconductor components or for development and validation of manufacturing processes. Currently, semiconductor companies invest 50-100 billion CZK annually in the purchase of these technologies.
- Tescan, a Brno-based company majority owned by a foreign investment fund through a Luxembourg company, manufactures electron microscopes and is working on the development of an electron lithograph for the production of nanostructures and for prototyping microchips. The launch of the lithograph is planned.
- CRYTUR - owned by Czech capital - is the world's largest manufacturer of detection units for electron microscopy and Europe's largest producer of single crystal optics for lasers, with 400 employees. More than half of all wafers and semiconductor devices produced in the world that are inspected by electron beam encounter CRYTUR detectors in the devices of a number of manufacturers. The need for electron inspection in semiconductors is increasing with shrinking chip architectures and 3D structures. With significant investment, CRYTUR is now positioning itself as a supplier of larger

electron optics packages where its detectors are part of the total solution. The company's large development capacity and patent portfolio also help to make this possible.

- UCT Fluid Delivery Solutions, s.r.o., based in Liberec, is a unique company specializing in custom manufacturing and deliveries to the semiconductor industry. Its final products are distribution systems and integrated modules used as one of the segments of the chip production line.
  The company started as a small Czech family business in 2000 and is now part of a US-based holding company. Production is divided into three phases - plastic machining, plastic welding and subsequent assembly in the cleanroom. It employs more than 500 people. The company's sales for 2023 are approximately CZK 3.3 billion.
- SVCS, based in Valašské Meziříčí, has only fifty employees and a turnover of around CZK 100 million. However, it manufactures furnaces for deposition of thin layers on semiconductor wafers, which are used for chip production. According to information from the industry, despite being an SME, the company is globally competitive.
- EP ROŽNOV, s. r. o. is able to build a clean room including the distribution of ultrapure gases and liquids.
- Ultra Clean Holdings Inc. (UCT) is an American company offering mainly chemical management and distribution solutions for the semiconductor industry. The company's manufacturing plant is located in Liberec.
- Edwards Ltd. is part of the Swedish Atlas Copco Group. Edwards offers vacuum solutions. It has its plants in the Czech Republic in Brno and in Lutín near Olomouc.
- DG Solutions, a.s. specializes in high-precision engineering with a specific focus on the semiconductor industry. A key area of expertise is machining and processing of advanced materials such as molybdenum-copper, diamond-copper and single crystal materials into various sizes and shapes, especially for the cooling needs of semiconductor components - the manufacture of thermal switchgear.
- CoorsTek is an American company engaged in the production of artificial ceramics. The company's products are found in many semiconductor manufacturing machines. The company's plant is located in Turnov.
- The German company Exyte is a global leader in the planning, development and supply of equipment for ultra-clean rooms and for high-tech facilities used in semiconductor, battery cell, pharmaceutical, biotechnology and data centre manufacturing. In addition to the existing production in Krupka, the company has added new facilities in Hostomice and in the Triangle industrial zone near Žatec in 2023. There, it plans to increase the number of its employees in the country by 200 by the end of 2025. Cleanroom products for the semiconductor industry are manufactured in Žatec, and patented engineering products for the semiconductor industry are manufactured in Hostomice.
- STREICHER, spol. s r.o. Plzeň is part of the German multinational group STREICHER, which focuses largely on engineering production. Its main business is the production of vacuum equipment and components for science and research as well as for various industries, including the semiconductor industry. The company manufactures machines used by the semiconductor industry for cleaning, degassing, manufacturing components for chip production, etc. The range of services extends from initial development through production to final assembly.
- Asteelflash Plzeň is a part of Taiwanese ASE Technology Holding, Co., Ltd., which deals with semiconductor casing and testing.

Research and development and innovation

For many years, developments in the semiconductor industry have been surprisingly accurate to the predictions of Moore's Law, which states that the number of transistors on a chip doubles every 18 to 24 months. It is clear that current lithography technology, where the width of the junctions on a chip is just a few nanometres, is running up against quantum limits. The concept, called "More than Moore", is driven by the desire to miniaturise components that do not yet have such small structures, such as analogue circuits, passive components, photonic elements, sensors, radio-electronic components, etc. and incorporate them into current digital microelectronic chip structures. However, the real paradigmatic breakthrough in chip technology is represented by quantum technologies. In effect, this means to stop interpreting the quantum effects of extremely miniaturised elements as a hindrance, but to look at them as something that can be exploited. Quantum technologies are addressed in more detail in the National Quantum Strategy.

- Chip design is carried out by teams at the Faculty of Electrical Engineering of CTU (Department of Microelectronics), Faculty of Nuclear and Physical Engineering of CTU (CAPADS workplace), Faculty of Informatics of CTU (Department of Digital Design), Faculty of Electrical Engineering and Communication Technologies of CTU (Institute of Microelectronics), Faculty of Information Technology of CTU, Faculty of Informatics of MU. Within the Academy of Sciences, it is the Institute of Physics. The Institute of Photonics and Electronics of the Academy of Sciences of the Czech Republic used to deal with this, but it is primarily devoted to other topics. The Institute of Instrumentation Technology of the Academy of Sciences of the Czech Republic has been developing and methodologically developing electron lithography technology for creating structures on chips and for prototype preparation of chips for a long time. The Electron Optics Department develops electron microscopy techniques for the inspection of semiconductor structures and the Coherence Optics Department develops optical methods for wafer surface metrology.
- Related technologies are the subject of research at other departments, both universities and institutes of the Academy of Sciences. For example, the Institute of Instrumentation of the Czech Academy of Sciences is currently focusing significantly on the development of quantum technologies, which are key to the further development of semiconductor technology. Quantum technologies are primarily addressed by the National Quantum Strategy.

The research focuses on:

- Research on technologies for the production of semiconductor wafers (substrates) and thin-film technology for the preparation of epitaxial layers:
  - Research in the field of semiconductor crystal growth is carried out at the Faculty of Mathematics and Physics of Charles University. UK is also engaged in research on defect structure of semiconductors and their electrical and optical properties.
  - Substrate research in the Czech Republic is almost exclusively carried out by onsemi and ZČU is the only university in the Czech Republic dedicated to it. It is also the only manufacturer of semiconductor wafers in the Czech Republic. Research includes processes of bulk crystal growth (Si and SiC), production of polished wafers with diameters of 150 and 200 mm, growth of epitaxial layers (Si. SiC) with interest also in heteroepitaxial structures (GaAlN) and new semiconductor materials (Ga_2O_3, diamond).
  - Deposits of thin films of semiconductors of various types are developed at several departments, for example at the Institute of Physics of the CAS or at the Institute of Instrumentation Technology, and form the basis for structuring in chips, but they are also used in photovoltaic solar energy utilization or in sensors and photonics. Research on epitaxial growth technology (MBE, MOVPE) or PECVD and ALD deposition is being developed in the Czech Republic, complementing it with industrial technologies. Layer epitaxy is the focus of onsemi and also of CAS (GaN, InGaN, AlGaN, BN, GaAs InGaAs, diamond epitaxy...).
- Designing semiconductor devices for very high voltages

   - In research, this includes the Faculty of Electrical Engineering of the University of West Bohemia in Pilsen. Activity in this area is linked to the region. These components are used, for example, in trains, trams and other rolling stock. However, this is not pure design, but rather a higher level, i.e., the application area of already finished components. They do chip design and semiconductor technology issues only at the level of a few lectures and exercises in selected courses. That is, very marginally.
   - Power (power) electronics is also the focus of on semi, FEKT BUT in Brno, FEL CTU in Prague (study of new semiconductor structures, their design, characterization and applications; currently mainly the study of semiconductor nanostructures (diamond, silicon carbide), quantum bonded structures, development of new technologies for power electronics and applications of selected semiconductor components, radiation resistance of semiconductor structures) and the University of Mining and Metallurgy - Technical University Ostrava (again at the application level, similar to the ZČU).
   - On the theoretical level, the Jan Evangelista Purkyně University is also involved in the characterization of the cubic form of boron arsenide and the characterization of borophene. On the application level, the research focuses on the degradation, purification and recycling of various substances and materials.
- Analog amplifiers, AC/DC converters, DC/AC converters, voltage converters and other analogue circuits
   - Related to power management, power converters and analogue signal processing. Both CTU and BUT are active in this field.
- AD and DA converters and circuits for sensor signal processing
   - BUT is active in this area. A number of chips (mostly Sigma-Delta converters or Pipelined ADCs) have been designed for these applications. The production is carried out within the EUROPRACTICE programme.
- Digital design, VHDL, Verilog, FPGA
   - Very developed at BUT (FEKT) - custom microprocessors, custom gate arrays or mixed-mode chips - all on chip. Furthermore, the use of FPGAs especially in space applications (FEKT). At CTU, the FEL is similar and also at FIT (Department of Digital Design), where they do embed system design and use of programmable circuits (FPGAs) for applications with increased requirements for their safety.
- EDA and microprocessor architectures
   - Research and development in the field of advanced compilers (e.g., C/C++ languages) as well as compilers of low-level languages (e.g., assembler), simulation models or modelling languages is carried out by the Faculty of Information Technology of Brno University of Technology. These research areas belong to the core of EDA tool development. Advanced processor architectures, both of the RISC (Reduced Instruction Set Architecture) type, e.g., RISC-V, and CISC (Complex Instruction Set Architecture) type, e.g., Intel, in complex systems-on-chip (SoC) are the core of research at the Faculty of Informatics at CTU and the Faculty of Information Technology at BUT. The Faculty of Informatics is devoted to formal methods and parallel verification of complex systems applicable to processor architectures and embedded systems.
- Radiation detectors and semiconductor optical sensors
   - Radiation detectors and semiconductor optical sensors Radiation detectors for both scientific use (scientific instruments) and industrial use. Both CTU (Faculty of Nuclear and Physical Engineering - CAPADS centre and Faculty of Electrical Engineering), as well as the Faculty of Informatics of MU and the Faculty of Mathematics and Physics of Charles

University are active in this field. At CTU, chips are being developed for use in space probes and for evaluation electronics from particle detectors. Research is also carried out within the Academy of Sciences of the Czech Republic and the Research Centre Řež. Significant results in this direction have been obtained by the University of Science and Technology, which cooperates on the development of detectors with the CERN centre. It is the author of electronic systems for processing data from the detectors, and in cooperation with UTEF it has achieved the deployment of the system on the International Space Station ISS. MFF UK focuses on research into high-efficiency semiconductor detectors. It collaborates with Advacam s.r.o, a leading Czech manufacturer of detection systems for X-ray and gamma-ray detection.

- Semiconductor lasers
    - A strong area for the whole of Europe. Not always chip related. A semiconductor diode can be used as a light source. Lasers are mainly dealt with by the Academy of Sciences, the Institute of Physics, the Institute of Instrumentation and the Institute of Photonics and Electronics.
- Encapsulation and contacting of chips
    - The research is carried out at Brno University of Technology and ZČU in Pilsen. ZČU deals mainly with the encapsulation of power electronics into power modules. Onsemi and Hitachi Energy are also involved in the private sector.
- Organic semiconductors
    - Solutions related to efforts to replace inorganic materials with organic compounds. Active in this field are, for example, the Central European Institute of Technology (CEITEC) of BUT or the University of Chemical Technology in Prague / Faculty of Chemical Technology.
    - Significant results in the field of organic semiconductors have ZČU, which has, for example, proven technologies for the construction of organic transistors.
- Spinelectronics
    - Quite substantial resources are allocated to this area of research. However, basic research has not yet been translated into applied research. The Institute of Physics of the Academy of Sciences of the Czech Republic and the New Technologies Research Centre (NTC) of the University of West Bohemia are working on this topic.
- Electron and optical lithography and related technologies
    - The technology of electron lithography, essential for prototyping microchips, has been developed for a long time at the Institute of Instrumentation of the CAS, including the technology of deposition of structures on semiconductor substrates. Research and development are focused on methodology, on the techniques themselves and on the development of related devices. The same applies to optical lithography, including high resolution nonlinear optical lithography for the creation of nano-3D structures.
- Electron optics and electron microscopy
    - Methodologically, physically, technically and application-oriented research in the field of electron microscopy and electron optics in general is the focus of the Institute of Instrumentation of the CAS. The Institute is also the coordinator of the National Centre for Advanced Photon and Electron Optics, closely cooperates in research with Thermofischer Scientific and develops electron microscopy techniques for use in materials research with relevance for the semiconductor industry.

Annex 3: Chip support programmes

Chips JU

Chips JU is one of the institutionalised European research partnerships of the EU's 9th Framework Programme for Research and Innovation Horizon Europe (2021-2027) implemented through the Brussels-based Joint Undertaking of the same name. The Chips JU was established by **Council Regulation (EU) 2023/1782 of 25 July 2023 amending Council Regulation (EU) 2021/2085 setting up joint undertakings under the Horizon Europe programme as regards the Chips JU**. Its members are the EU represented by the European Commission, the industry association INSIDE (i.e., the European industry association open to all entities engaged in R&D and innovation in the field of embedded and cyber-physical systems), the industry association AENEAS (i.e. The institution responsible for the activities of Chips JU in the Czech Republic is the Ministry of Education and Science of the Czech Republic as the coordinator of international cooperation in research and development.

Other programmes are not currently specifically targeted at supporting the semiconductor sector.

Annex 4: IPCEI Major Projects of Common European Interest

Important Projects of Common European Interest (IPCEI) are governed by the Commission's specific Communication Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of an important project of common European interest (2021/C 528/02). According to Article 107 TFEU, the following may be considered compatible with the internal market: aid to facilitate the execution of an important project of common European interest.

The Czech Republic is a signatory to the Declaration on the European Initiative on Processors and Semiconductor Technologies of 7 December 2020. The Declaration was the basis for the European IPCEI ME/CT initiative, which is a major innovation project in the field of processor and chip design for artificial intelligence (AI), design of chips for communication (5G, 6G and others) and communication technology, development and production of these chips in Europe, advanced casing technologies for heterogeneous integration and semiconductor substrates for radio frequency and power devices, which will help restore capacity in areas where Europe is heavily dependent on imports of raw materials and technologies and ensure the competitiveness of EU industry in global markets.

The notified public support at European level of €8.1 billion is complemented by additional private resources of €13.7 billion and involves 14 Member States with 68 R&D projects, including the first industrial deployment phase. In addition, there are 40 associated projects listed in the notification and in total and more than 600 indirect partners.

The Czech Republic has joined this initiative with four projects. The notification decision was issued on 8 June 2023 under the designation "State Aid SA.101141 (2023/N) - Czechia". These are two projects with notification and two projects implemented as "associated partners", which are part of the whole IPCEI ME/CT ecosystem and their support is governed by the GBER rules for IPCEI projects and their implementation is currently underway.

The projects notified by the Czech Republic have a total investment allocation of approximately CZK 5 billion, where the amount of public support is approximately CZK 1.5 billion. The first part in the amount of CZK 1.1 billion is implemented from 2024 within the National Recovery Plan, the second part in the amount of CZK 400 million is implemented from 2024. The first CZK 400 is subject to the National Semiconductor Strategy and will be financed from other sources.

Annex 5: Application of artificial intelligence in the semiconductor sector

This appendix discusses the potential application of AI systems in the semiconductor sector

AI for semiconductor design

Creating advanced machine learning and AI algorithms to automate design processes, optimize chip performance, reduce power consumption and minimize manufacturing costs.

AI implementation for rapid prototyping and simulation, enabling designers to iterate and test designs faster before production.

Optimising manufacturing processes with AI

Use AI to control, monitor and optimize manufacturing processes in real time, including predicting equipment maintenance, detecting and predicting manufacturing defects and automating quality control.

Development of intelligent robotic systems for automation of complex and repetitive tasks in production lines.

Integrating AI into manufacturing and test equipment, including the development of advanced sensor and control systems to improve accuracy, efficiency and equipment performance.

Supply chain and logistics management

Implement AI to optimize supply chains and logistics operations, including demand forecasting, inventory optimization and more efficient product distribution.

Annex 6: Analysis of the power electronics market

According to an analysis by MarketsandMarkets, the global power semiconductor market size was estimated at USD 44.1 billion in 2022. It is estimated to reach an expected value of USD 61 billion by 2028, registering a Compound Annual Growth Rate (CAGR) of 5.7% during the forecast period (2023 to 2028) (MarketsandMarkets, 2023). Other sources (SNS Insider, 2022) put the market size at USD 39.66 billion in 2022 and growth to USD 54.69 billion by 2030. In this case, the average annual growth rate (CAGR) is estimated at 4.1%. Increasing demand for renewables, electric vehicles, and portable devices with integrated battery are considered to be the major growth drivers.

Power semiconductors play a key role in the green transition. They are used in transportation (both automotive and train), consumer electronics, industrial applications and green energy. These sectors will also account for the highest percentages of demand. This segment is also moving towards miniaturisation and integration.

Today, new materials are gaining ground in the field of power electronics. Historically, silicon MOSFETs and bipolar transistors (IGBTs) have been used. Now, materials based on gallium nitride (GaN) and silicon carbide (SiC) are also starting to be used. These materials have a higher energy density and higher efficiency compared to a standard silicon MOSFET. Silicon carbide is suitable for high voltage and current applications. These properties are particularly suitable for electromobility, traction or solar farms. Gallium nitride, on the other hand, can operate at a higher frequency but with a lower voltage. It is particularly suitable for voltage converters. It is used, for example, in power supplies that convert alternating to direct current in computing.

The most important companies operating in the power electronics market are Infineon Technologies (EU, Germany), ON Semiconductor (onsemi, USA), STMicroelectronics (Switzerland, but the company's roots go back to Italy and France), Mitsubishi Electric Corporation (Japan) and Vishay Intertechnology (USA). Other players include Fuji Electric (Japan), NXP Semiconductors (EU, Netherlands), Renesas Electronics Corporation (Japan), Texas Instruments (USA) and TOSHIBA (Japan). Mention should also be made of the US-based WOLFSPEED, which has advanced silicon carbide-based manufacturing.

Market drivers

The main drivers of the power electronics market are electrified transport vehicles and systems (wheeled vehicles - mainly automotive; rail vehicles; ships and aerial vehicles). Then there are technologies for the power industry, with the electrical grid segment in particular, with distribution, transmission and industrial segments experiencing significant growth. Consumer electronics is also an important market driver. Renewable energy is also expected to grow rapidly. Semiconductors (both power and non-power) are now required by a huge range of consumer products, including communication devices (smartphones, tablets, smartwatches and other devices), computers (personal and business circuit boards), entertainment systems and home appliances. The primary consumer of semiconductors in this market segment is smartphone manufacturers. In recent years, there has been strong competition in the smartphone industry. The increasing use of mobile phones is also expected to drive the global market. For instance, according to Ericsson, the global smartphone data traffic is expected to grow from 32 exabytes in 2019 to 221 exabytes per month by 2026. According to India Brand Equity Foundation (IBEF), the Indian Appliances and Consumer Electronics (ACE) market is expected to register a 9% CAGR. The growing demand for energy-efficient battery-powered portable devices can also be expected (Straits Research, 2022).

Acceptance in various sectors

The use of power semiconductors in the IT and consumer electronics, automotive, energy distribution and rail transport sectors are expected to be supported by a steady increase in non-conventional energy sources. Growing demand for more efficient power management and new consumer safety features is driving uptake in the automotive industry. For example, some electric vehicle applications have already started to use SiC technology for low-power applications such as battery chargers, auxiliary DC-DC converters and solid-state circuit breakers. Today, more efficient powertrains that use semiconductor technologies such as silicon carbide (SiC) make it possible to achieve high voltage and power requirements at low cost. Therefore, these applications provide an opportunity for further development.

Analysis of market segments

The global power semiconductor market is segmented on the basis of component, material, end-user industry, and region. Findings from the report (Straits Research, 2022) are cited below.

By component, the global power semiconductor market is segmented into discrete, module, and power integrated circuits. The power integrated circuits segment accounts for the largest market share and is estimated to grow at a CAGR of 1.9% during the forecast period (2023 to 2030) (Straits Research, 2022). Power integrated circuits (ICs) are used as rectifiers or switches in high-voltage applications, including power supplies, power components in automobiles, solar panels, and trains. The on state of ICs allows electricity to flow and the off state stops it. They increase system efficiency and reduce energy losses. Power integrated circuits are used in a variety of power applications because they have a much smaller overall physical size than discrete circuits. Their smaller size results in lower power consumption, which increases the demand.

The discretionary segment is the second largest (Straits Research, 2022). Power semiconductors mainly include IGBT, MOSFET, SiC and GaN. One of the significant trends in discrete semiconductors is efficient power management. Smartphone is one of the major consumers of discrete semiconductors. These semiconductors in the adapter play a key role in maintaining the required current and voltage levels, as companies are developing smartphone chargers that could charge devices for significantly shorter periods of time, making their rated current significantly increased. This factor is expected to lead to the development of more robust discrete power semiconductors.

According to the material, the global power semiconductor market is segmented into silicon/germanium, silicon carbide (SiC), and gallium nitride (GaN). The silicon/germanium segment accounted for the largest market share and is estimated to grow at a CAGR of 1% during the forecast period (Straits Research, 2022). This segment is witnessing several product innovations that are propelling the segment growth. For instance, in May 2020, Nexperia announced a range of new silicon-germanium (SiGe) rectifiers with reverse voltage of 120 V, 150 V, and 200 V, which combine the high efficiency of their Schottky counterparts with the thermal stability of fast recovery diodes. Targeting the automotive, communications infrastructure and server markets, SiGe rectifiers are particularly advantageous in high-temperature applications such as LED lighting, engine controllers or fuel injection.

The silicon carbide (SiC) segment is the second largest. Semiconductors made from silicon carbide (SiC) set high standards for heat loss, switching speed and size. Power electronics provide significant energy savings (higher efficiency). These savings translate, for example, into an increased range per battery charge. SiC, a broadband technology that is faster and more efficient than silicon-based devices, is finding applications and competing with IGBTs and MOSFETs in various segments. All the above factors are contributing to the sustained growth (Straits Research, 2022).

By end-user industry, the global power semiconductor market is segmented into automotive, transportation, consumer electronics, IT & telecom, military & aerospace, energy, industrial, and others. Consumer electronics accounted for the largest market share and is estimated to grow at a CAGR of 2% during the forecast period (Straits Research, 2022). The deployment of power semiconductors is expected to be significantly impacted by these market trends. Both the PC and wearables markets follow the same pattern. Manufacturers are demanding shorter charging times from their customers. A cornerstone of their marketing approach is the provision of fast charging adapters by manufacturers such as OPPO, One+, Motorola, Samsung and Apple. These elements are helping the expansion of the segment.

Regional analysis

By region, the global power semiconductor market is segmented into North America, Europe, Asia Pacific, Latin America, and the Middle East along with Africa.

According to the report (Straits Research, 2022), Asia Pacific accounted for the largest market share and is estimated to grow at a CAGR of 3.6% during the forecast period. Owing to the region's dominance in the global semiconductor trade and support from government regulations, Asia Pacific is projected to dominate the power semiconductor market. China, Japan, Taiwan, and South Korea together account for approximately 65% of the global discrete semiconductor market. Other countries, including Vietnam, Thailand, Malaysia and Singapore, contribute significantly to the region's market dominance. The Indian Electronics and Semiconductor Association claims that India is a desirable location for international R&D facilities. Thus, investment in the semiconductor business is expected to come from the government's continued Make in India push. In addition, the region is a manufacturing powerhouse for electronics, producing millions of electrical products annually for local use and export. The market share of the industry under study is strongly influenced by the growing production of electronic goods and parts.

Furthermore, the source (Straits Research, 2022) states that the second largest region is North America. It is estimated to reach an expected value of USD 8.5 billion by 2030, registering a CAGR of 2.6%. The North American region is an early adopter of new technologies in manufacturing, design and research in the semiconductor industry. The growth of the power semiconductor market in North America strongly correlates with the growth of end-user industries such as automotive, IT & telecom, military & aerospace, consumer electronics, and others. According to the Semiconductor Industry Association (SIA), the semiconductor industry directly reported revenues of $40.0 billion for January 2021, up 13.2% from the January 2020 total of $35.3 billion. SIA represents 98% of the U.S. semiconductor industry by revenue and nearly two-thirds of chip companies outside the U.S. Shortages in semiconductor supply in the region, fuelled by US policy changes, are also expected to boost domestic investment in manufacturing and equipment (Straits Research, 2022).

Europe is the third largest region. The European region is home to some of the world's most important technology centres and is a major driver of modern technology. Increasing penetration of advanced technologies and growing adoption of semiconductors in various industries are driving the market growth. Growing involvement of regional governments in supporting research programs has boosted many semiconductor-oriented industries and is supported by an environment of high-tech connectivity. For example, the German government has committed to increase the number of research companies to 20,000 and innovative companies to 140,000 by 2020. According to the World Semiconductor Trade Statistics (WSTS) and SIA, semiconductor sales in Europe increased by 6.4% in 2019 (Straits Research, 2022). Such developments are driving market growth.

Reasons for market growth

1. Electromobility and the automotive industry: With the growing popularity of electric vehicles (EVs) and hybrid vehicles, the demand for power semiconductors is increasing. These chips are crucial for power management and efficiency, from charging batteries to powering the engine.

2. Renewable energy: The development of solar and wind power plants requires power semiconductors for efficient energy transmission and conversion. These technologies help minimize energy losses and improve the overall efficiency of the systems.

3. Industrial Automation & Power: Upgrading of manufacturing facilities and power grid infrastructure is also supporting the growth of the power semiconductor market. In industrial applications, these chips are used to control motors, power electronics, and power systems.

4. Consumer electronics: while performance requirements are typically lower in this category, innovations in consumer electronics such as smart homes and personal electronics still require advanced semiconductor components for power management and functionality.

5. Technological advances. These innovations open up new applications and markets.

For these reasons, the power semiconductor market can be expected to grow in the coming years, both due to expansion of existing markets and penetration into new applications (Straits Research, 2022).

Sources

MarketsandMarkets (2023), Power Electronics Market. (cited 2024-03-26). Available from: https://www.marketsandmarkets.com/Market-Reports/power-electronics-market-204729766.html

SNS Insider (2022), Power Electronics Market. (Cited 2024-03-26). Available from: https://www.snsinsider.com/reports/power-electronics-market-1246

Straits Research (2022), Power Semiconductor Market. (Cited 2024-03-17) Available from: https://straitsresearch.com/report/power-semiconductor-market

Annex 7: Market analysis of integrated circuit design

According to a study by Global Fabless IC Market (Market Research Future, 2024), the global integrated circuit design market has been growing significantly over the past few years. It is expected to reach a value of USD 439.5 billion by 2032, at an average annual growth rate of 17.9% during the forecast period 2024-2032.

The business model of integrated circuit designers (also referred to as fabless) is characterised by companies with this business model designing integrated circuits, which they then have manufactured by specialist integrated circuit companies. They then usually sell the manufactured ICs under their own brand name or to their partners.

Advances in technology in the semiconductor industry, together with the capital intensity of the IC production itself, are supporting the market trend towards greater specialisation by companies. By not operating their own integrated circuit fabs, fabless companies can focus entirely on the design of the integrated circuits themselves, allowing them to provide innovative, high-performance chips without the cost of operating and expanding fabs. This approach leads to cost savings, greater flexibility and time savings. Fabless companies are more flexible and can easily adapt to market changes.

Overall, the integrated circuit design market is expected to flourish in the coming years owing to the demand for advanced semiconductor solutions and cost advantages of outsourcing manufacturing.

Market Research Future's (MRF) 2024 market study provides detailed information on industry trends and dynamics, market size, competitive landscape, and growth opportunities. The global integrated circuit design market has been segmented based on type, target market, and region. By type, the market is segmented into microcontrollers (MCUs), digital signal processors (DSPs), graphics processing units (GPUs), application-specific integrated circuits (ASICs), power management integrated circuits (PMICs), display driver integrated circuits, memory integrated circuits, and others. Memory ICs accounted for the largest market share, with a market value of USD 24.01 billion in 2023, and is projected to grow at an average annual rate of 18.4% during the forecast period. Based on target market, the market has been segmented into consumer electronics, automotive, industrial, telecom, healthcare, aerospace along with defence, and others. Telecommunications is the largest target market with a value of USD 34.49 billion in 2023 and this market is projected to grow at an average annual rate of 17.7% during the forecast period. By region, the market is segmented into North America, Europe, Asia Pacific, Middle East along with Africa, and South America. Asia Pacific held the largest market share with a market value of USD 46.66 billion in 2023, and the market is projected to grow at an average annual rate of 18.7% during the forecast period.

MRF's study also analysed the major players who have contributed significantly to the growth of the global integrated circuit design market. These include Qualcomm Inc, Broadcom Inc, Silicon Labs, MediaTek Inc, NVIDIA Corporation, Xilinx Inc, Himax Technologies Inc, Ambarella Inc, Cypress Semiconductor Corporation, and Dialog Semiconductor PLC.

Table 1: Global Integrated Circuit Design Market 2019 to 2032 in US$ Billion (Market Research Future, 2024)

Entity	2019	2020	2021	2022	2023	2025	2032	CAGR (2024 to 2032)
Microcontrollers (MCUs)	14,21	15,87	16,82	15,76	13,20	16,67	53,61	17,5 %
Digital Signal Processors (DSP)	13,14	14,41	15,00	13,79	11,33	13,76	37,96	15,0 %

Graphics processing units (GPUs)	16,61	18,89	20,39	19,46	16,59	21,70	78,49	19,5 %
Application Specific Integrated Circuits (ASICs)	18,80	21,22	22,75	21,55	18,25	23,56	81,77	18,8 %
Power Electronics Integrated Circuits (PMICs)	7,84	8,75	9,26	8,67	7,26	9,15	29,32	17,5 %
Display drivers (PMICs)	6,62	7,43	7,92	7,46	6,29	8,03	26,93	18,2 %
Memories	25,23	28,37	30,28	28,57	24,10	30,88	104,42	18,4 %
Other	9,27	10,17	10,60	9,75	8,01	9,72	26,97	15,1 %
Total	**111,72**	**125,11**	**133,02**	**125,01**	**105,03**	**133,47**	**439,47**	**17,9 %**

MRFR's study also analysed the major players who have contributed significantly to the growth of the global integrated circuit design market. These include Qualcomm Inc, Broadcom Inc, Silicon Labs, MediaTek Inc, NVIDIA Corporation, Xilinx Inc, Himax Technologies Inc, Ambarella Inc, Cypress Semiconductor Corporation, and Dialog Semiconductor PLC.

Sources

Market Research Future (2024), Global Fabless IC Market Research Report - Forecast to 2032. Market Research Future.

Annex 8: Embedded AI market analysis

Embedded AI refers to AI systems that are directly integrated into end devices. According to the study Embedded AI Market (Market research future, 2024), the future of the global embedded AI market is a promising market. The embedded AI market is primarily driven by the growing demand for intelligent and autonomous systems as well as the increasing development of Al and ML technologies. According to Market research future, the global embedded AI market has been growing steadily over the past few years. It is expected to reach a value of USD 43.44 billion by 2032, growing at an average annual growth rate of 20.9% during the forecast period 2023-2032. The current market size is estimated at USD 9.54 billion. The hardware segment alone had a market value of approximately USD 4 billion in 2023 and is projected to grow at an average annual market growth rate of 19.8% during the forecast period.

Examples of embedded AI applications are self-driving cars, drones, intelligent manufacturing robots or care robots. The basic offering of intelligent systems includes a combination of hardware, software and data. By integrating them with AI, advanced systems can be developed that enable data processing and help in detecting patterns and predicting future outcomes directly at the end device without the need for remote computations in the data centre.

It is predicted that up to 63% of companies will invest in AI and ML to automate business processes by 2024. Advances are evident in various learning algorithms and applications. Systems with embedded AI help in smarter decision making through big data processing.

Sources

Market research future (2024), Global Embedded AI Market Research Report - Forecast to 2032. (Cited 2024-05-20) Available from: https://www.marketresearchfuture.com/reports/embedded-ai-market-12254

Annex 9: Analysis of public support for research and development

This Annex focuses on the analysis of R&D support in the semiconductor sector. It covers both private enterprises and public research institutions (universities, institutes of the Academy of Sciences and teaching hospitals). The data are viewed from different dimensions. Both at the level of public support providers, type of applicant or position in the value chain. In addition to direct public support, the analysis also includes indirect support. The analysis covers the period 2018 to 2022 and uses data from the Research, Development and Innovation Information System (RDIIS).

Total public sector support for R&D[5]

Overall, CZK 2.3 billion was spent on public support for R&D in the Czech Republic between 2018 and 2022 (Table 1). Indirect support is estimated at around 60 million crowns. The highest support was recorded in 2019 and 2020, when more than 500 million crowns were released annually to support projects. After 2020, however, there is a drop to around CZK 344 million in 2022. The drop from the maximum allocation in 2020 is 38.6%.

The largest provider is the Technology Agency of the Czech Republic (TA CR), which has provided grants of approximately CZK 1 billion. The second largest provider is the Ministry of Education, Youth and Sports of the Czech Republic (MŠMT) - CZK 730 million. The Ministry of Industry and Trade of the Czech Republic (MIT) and the Grant Agency of the Czech Republic (GA CR) are in third and fourth place, with both providers awarding approximately CZK 230 million in support.

Table 1: Total direct support to the semiconductor sector and its suppliers in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
GA CZECH REPUBLIC	43 940	52 874	42 923	45 389	44 681	229 807
MIT	55 967	59 786	61 547	30 368	22 338	230 006
MOE	138 890	150 840	167 075	151 676	121 983	730 464
MV	6 337	9 682	10 090	10 028	7 941	44 078
TA ČR	177 887	263 879	278 101	208 236	146 885	1 074 988
Total	423 021	537 061	559 736	445 697	343 828	2 309 343

Five providers provide direct public R&D support to the semiconductor sector. These are the Grant Agency of the Czech Republic (GA CR), which provides support mainly for basic research projects, the Ministry of Industry and Trade of the Czech Republic, which supports applied research, the Ministry of Education, Youth and Sports of the Czech Republic, which provides support mainly for basic research and research infrastructures, the Ministry of the Interior of the Czech Republic (MoI), which supports security research, and the Technology Agency of the Czech Republic, which supports applied research. The structure of direct public support is illustrated in Figure 1.

[5] Research by suppliers of equipment for the production of integrated circuits is also included in the support of R&D activities. However, their products also find applications outside the semiconductor sector.

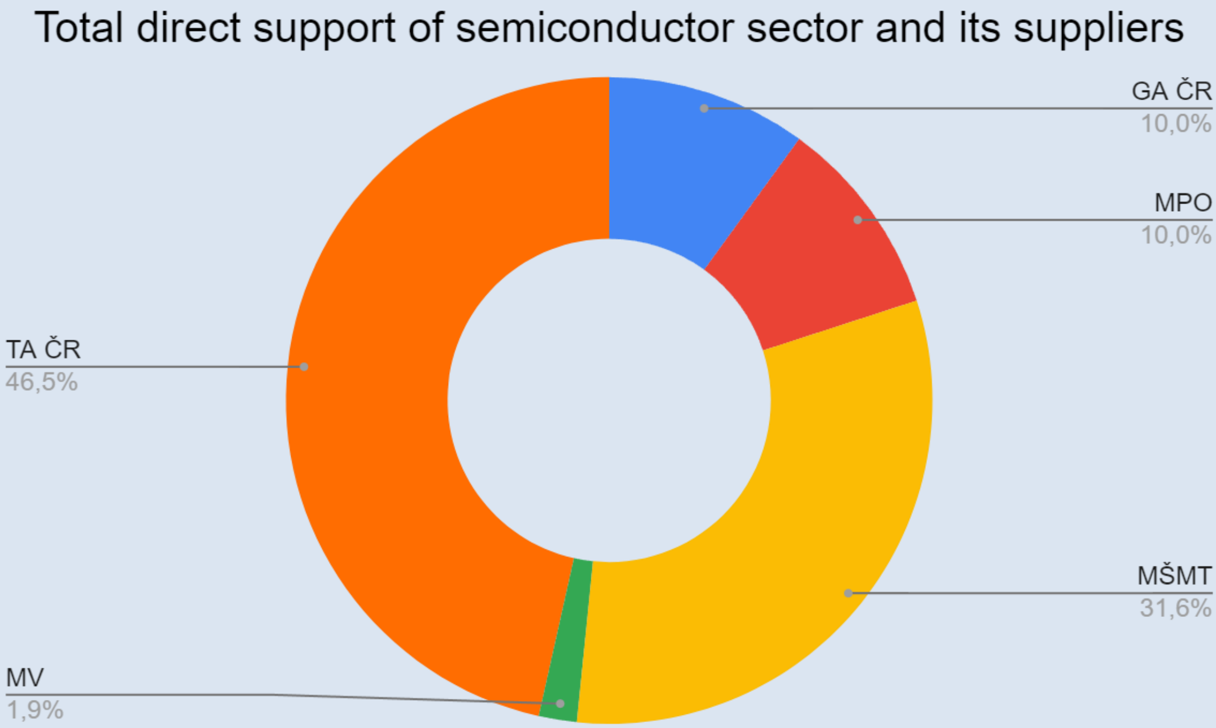

Figure 1: Structure of providers of direct public support for R&D in the semiconductor sector (own)

The total public support to public research organisations (universities, institutes of the Academy of Sciences and teaching hospitals[6]) amounted to approximately CZK 1.7 billion (excluding the large research infrastructures CzechNanoLab and the Centre for Research and Development of Plasma and Nanotechnological Surface Treatments, for which the Ministry of Education and Science spent approximately CZK 497 million, the support would be CZK 1.2 billion). Approximately CZK 290 million was spent on basic research (Table 2). CZK 780 million was spent on applied research. A specific type of research is partnerships (the Partnership Network for Research and Development of Imaging and Lighting Technology and Optoelectronics for the Optical and Automotive Industry and the Partnership for Excellence in Superprecision Optics), for which CZK 115 million was spent on public research organisations (the Joint Laboratory of Optics of Palacký University and the Institute of Physics of the CAS and the Institute of Plasma Physics of the CAS). This support is granted by the Ministry of Education and Science, but is classified as additional support for applied research in the analysis. In total, therefore, almost CZK 900 million was spent on applied research.

The highest support was recorded in 2020 (CZK 439 million). After 2020, there was a decrease in financial allocation to CZK 249 million in 2022, a decrease of 43.3%.

Table 2: Total direct support to public research organisations in thousands CZK (own)

Provider	2018	2019	2020	2021	2022	Total
GA CZECH REPUBLIC	43 940	52 874	42 923	45 389	44 681	229 807
MIT	20 679	26 014	30 074	15 581	11 066	103 414
MOE	132 881	140 619	155 996	137 848	107 863	675 207
MV	6 337	8 477	6 990	6 843	5 584	34 231

[6] University hospitals have been involved in research in the field of radiation resistant electronics and radiation sensors.

Provider	2018	2019	2020	2021	2022	Total
TA ČR	76 128	156 150	202 881	124 679	79 635	639 473
Total	279 965	384 134	438 864	330 340	248 829	1 682 132

In the segment of public research organisations, the most important provider is the Ministry of Education, Youth and Sports of the Czech Republic (Figure 2). This is due to the support of large research infrastructures operated by public research organisations.

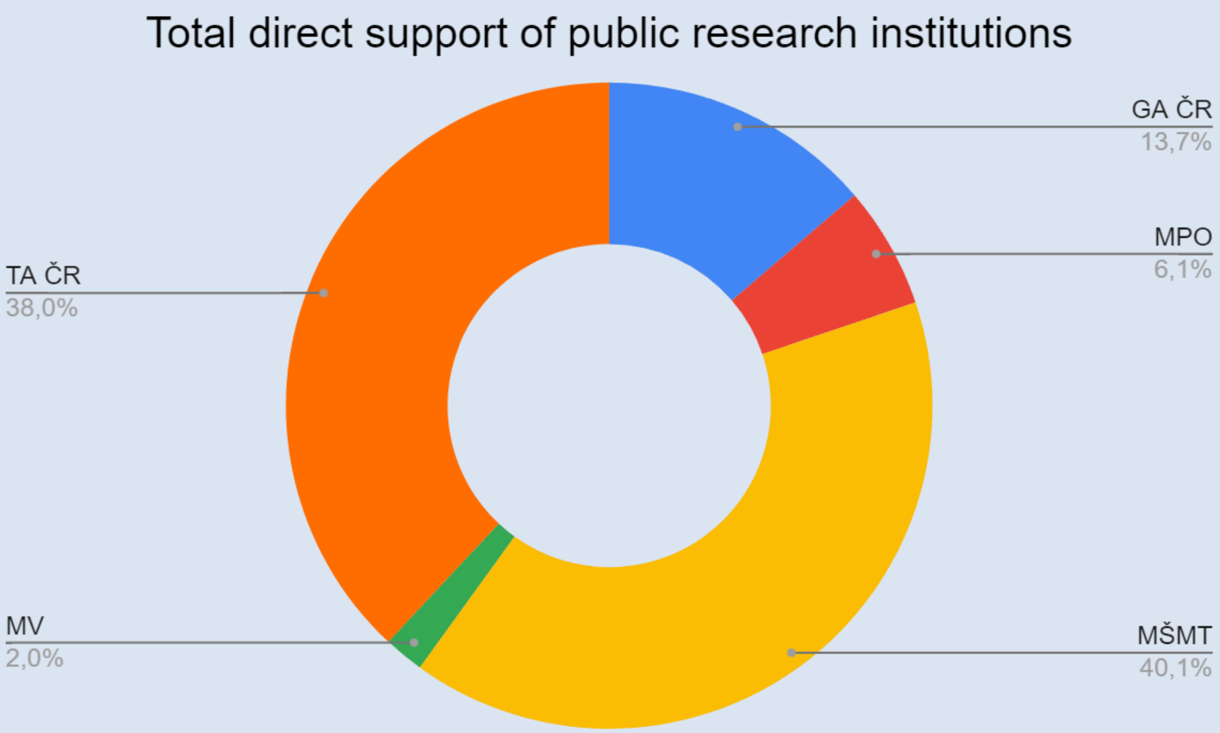

Figure 2: Structure of providers of direct public R&D support in the segment of public research organisations (own)

Within the private enterprise segment (Table 3), total direct public aid of CZK 627 million and indirect public aid of an estimated CZK 59 million were recorded. Indirect aid thus amounts to 8,6 % of the total aid. In terms of direct aid, the highest amount was allocated in 2019, amounting to CZK 153 million. Thereafter, there was a drop to CZK 95 million, a reduction of 38%.

The largest provider was the Technology Agency of the Czech Republic with an allocation of CZK 435.5 million. This was followed by the Ministry of Industry and Trade with a financial allocation of CZK 126.6 million. The Ministry of Education, Youth and Sports of the Czech Republic provided national co-funding under the ECSEL Joint Technology Initiative, which is the predecessor of the Chips Joint Undertaking (Chips JU). Furthermore, the MoEYS provided funding under the Eurostars programme, which is aimed at supporting SMEs and is part of the European Partnership for Innovative SMEs. Furthermore, the INTER-EXCELLENCE programme, which supports the development of international cooperation in research and development, as well as through the Operational Programme Research, Development, Education and the Partnership Network for Research and Development in Imaging and Lighting Technology and Optoelectronics for the Optical and Automotive Industries and the Partnership for Excellence in Super precision Optics.

Table 3: Total direct support to private enterprises in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
MIT	35 288	33 772	31 473	14 787	11 272	126 592

MOE	6 009	10 221	11 079	13 828	14 120	55 257
MV	0	1 205	3 100	3 185	2 357	9 847
TA ČR	101 759	107 729	75 220	83 557	67 250	435 515
Total	143 056	152 927	120 872	115 357	94 999	627 211

Within the private enterprise segment (Figure 3), TA CR is the dominant provider of direct public support. The Agency is responsible for almost 70% of direct public support to private enterprises. The share of the Ministry of Industry and Trade of the Czech Republic is approximately 20 %.

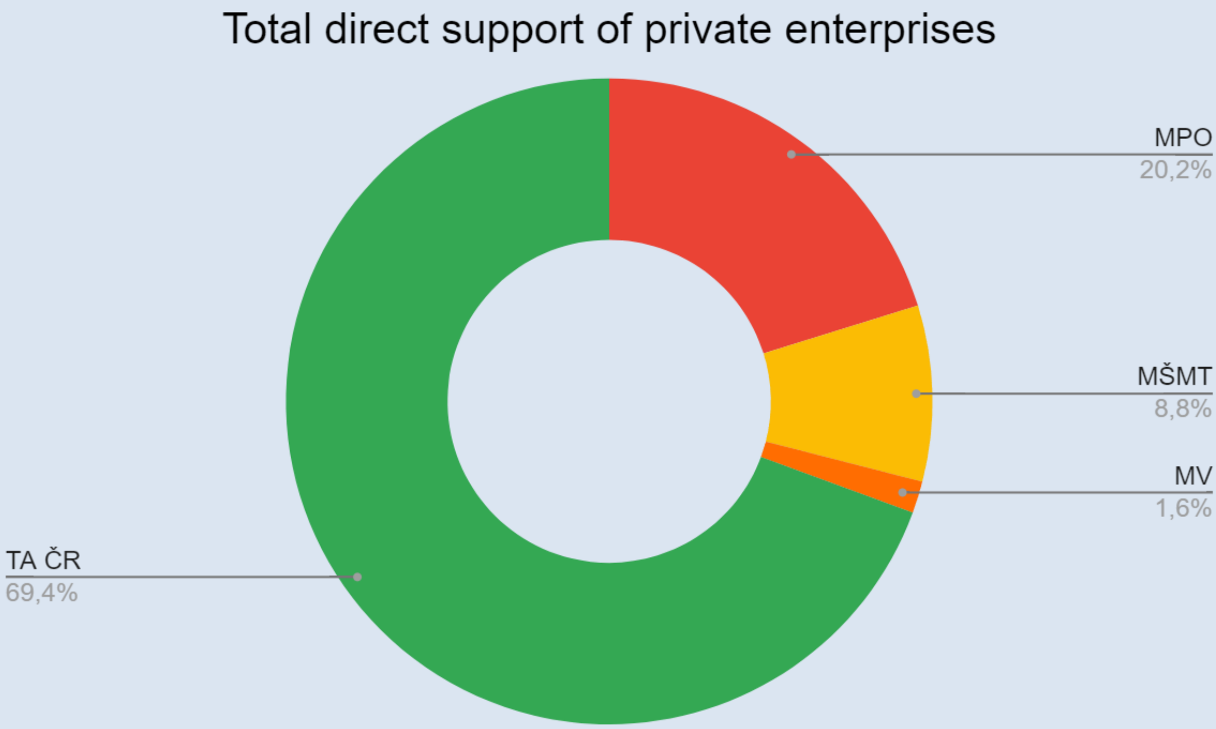

Figure 3: Structure of providers of direct public support for R&D in the private enterprise segment (own)

Analysis of the dominant programmes of individual support providers

The Grant Agency of the Czech Republic (Figure 4) allocated the largest amount of funds (124 million CZK) from the Standard Projects programme (54%), followed by the Grant Projects for Excellence in Basic Research EXPRO programme with an allocation of 80 million CZK (34.8% of the total allocation), followed by Projects to Support Excellence in Basic Research (15.9 million CZK and 6.9% of the allocation) and the Junior Grants programme with an allocation of 9 million CZK (3.9% of the total allocation). Together, 99.6% of the provider's funds were allocated through these programmes.

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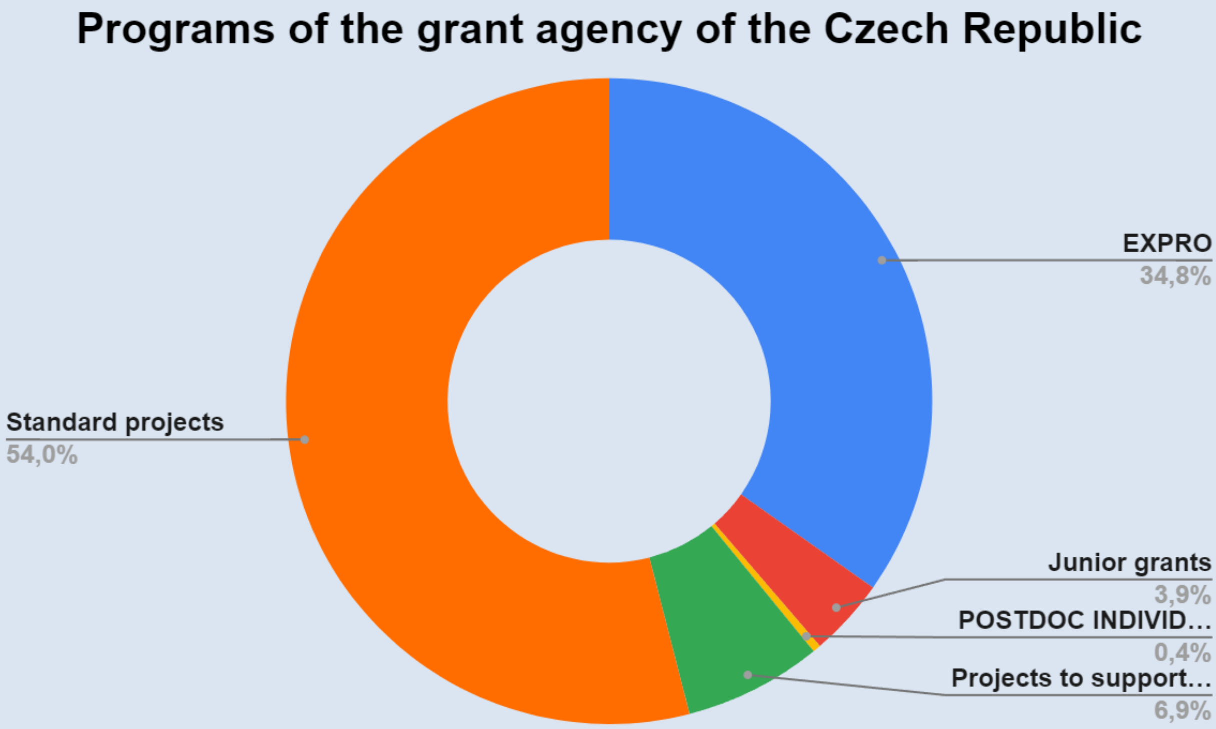

Figure 4: Allocation structure of the Czech Republic Grant Agency programmes (own)

The Ministry of Education, Youth and Sports (Figure 5) allocated funds predominantly from two programmes. Most of the funds were allocated from the Large Research Infrastructure Projects programme. The total amount was CZK 354.4 million. This is 48.5% of the total financial allocation of the provider. This was followed by the Operational Programme Research, Development and Education with an allocation of CZK 286 million (39.2%). Although this is an operational programme, these funds were allocated from the state budget according to the Research, Development and Innovation Information System. However, it is possible that these funds were retroactively reimbursed from the EU budget to the Czech Republic. Other programmes of the Ministry of Education and Science accounted for only a few percent of the total support. The INTER-EXCELLENCE programme received CZK 32.3 million (4.4% of the allocation), the National Sustainability Programme I 3.3% (CZK 24.3 million), and the ECSEL Joint Technology Initiative (CZK 24.2 million). The other programmes individually do not reach even 1% of the total financial allocation of the provider.

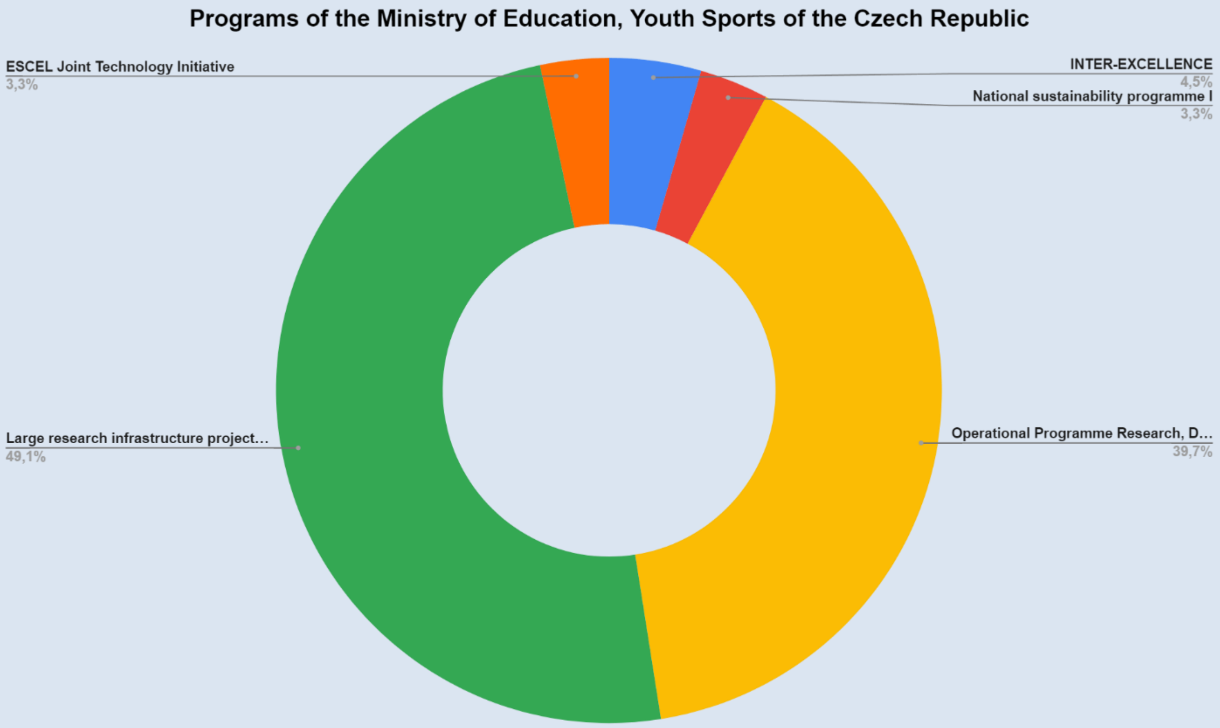

Figure 5: Allocation structure of the Czech Republic Grant Agency programmes (own)

Within the Ministry of Industry and Trade, 94.39% of the funds (CZK 217.1 million) were allocated through the TRIO programme.

The Ministry of the Interior used 100% of the Czech Republic's Security Research Programme.

Within the Technology Agency of the Czech Republic (Figure 6), the dominant programme of direct public support for research and development is the Programme for Support of Applied Research, Experimental Development and Innovation National Centres of Competence, which accounts for 31.1% (CZK 334.6 million) of the total allocation of the provider's funds. This is followed by the Centres of Competence programme with an allocation of CZK 222.7 million (20.7%), the Trend programme with an allocation of CZK 215.3 million (20% of the total allocation) and the EPSILON programme in support of applied research and experimental development with an allocation of CZK 198.8 million (18.5%). Together these programmes account for 90.4% of the provider's total allocation. Mention should also be made of the DELTA programmes for support of applied research, experimental development and innovation (2, 3, 4 and 7), which are bilateral and multilateral cooperation programmes with a total allocation of CZK 71.5 million (6.7% of the provider's financial allocation). The rest of the programmes contributed to the total allocation in the order of one percent.

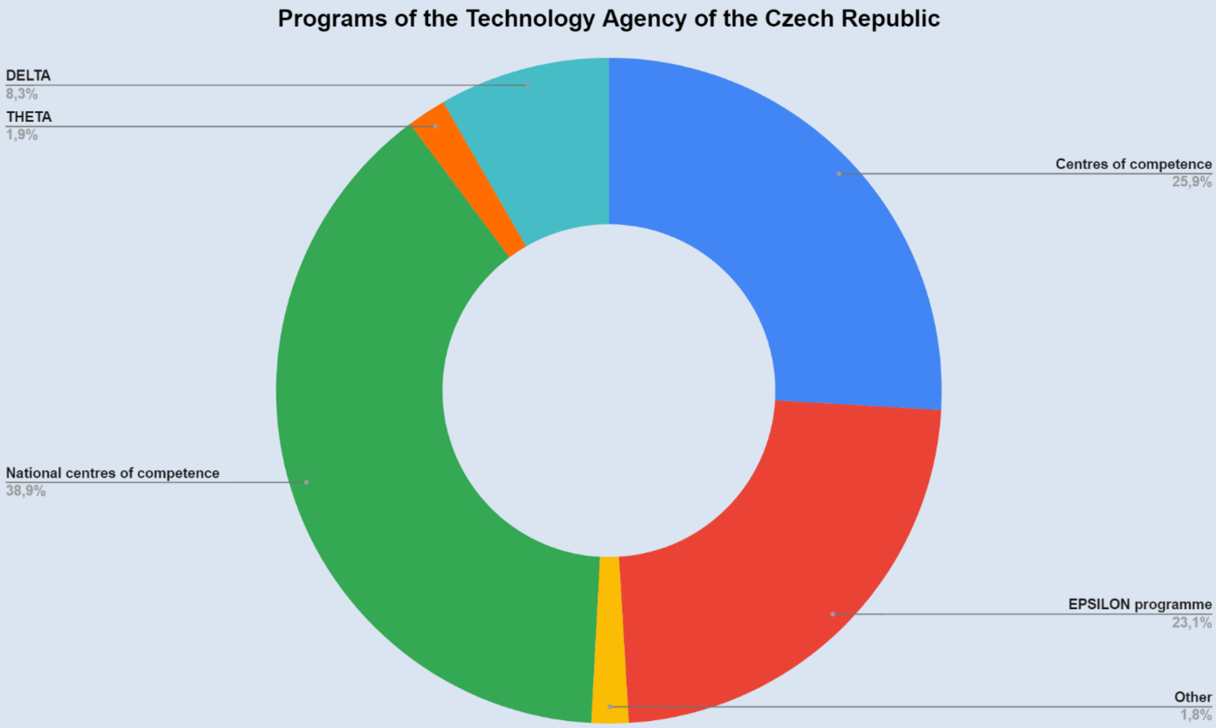

Figure 6: Allocation structure of the programmes of the Grant Agency of the Czech Republic (own)

Overview of public support provided for R&D&I along the value chain

This chapter provides a breakdown of public support for R&D along the different steps of the value chain. Specifically, it looks at the financial allocation to integrated circuit and discrete semiconductor manufacturing, integrated circuit design, radiation-hardened electronics, suppliers and non-specified research not included in the value chain.

Area of production

In the area of production (Table 4), the Czech Republic allocated direct public support for R&D amounting to CZK 84.5 million. The highest support was recorded in 2019 (CZK 21.6 million). Thereafter, there was a drop to CZK 13 million in 2022, a decrease of almost 40%.

Table 4: Total direct support in the field of integrated circuits and discrete semiconductor manufacturing in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
MIT	3 279	3 328	0	0	0	6 607
MOE	508	1016	0	1020	2039	4 583
TA ČR	16 177	17 223	18 808	10 176	10 998	73 382
Total	19 964	21 567	18 808	11 196	13 037	84 572

Within the public research organisations, CZK 29 million was allocated in the area of production. 55.4 million to private companies (Table 5). Direct R&D support to private companies in the field of integrated circuits and discrete semiconductor manufacturing increased by 36.1% in the period under review.

Table 5: Total direct support to private enterprises in the field of integrated circuits and discrete semiconductor devices in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
MIT	2 079	2 128	0	0	0	4 207
MOE	0	0	0	1020	2039	3 059
TA ČR	7 500	8 170	11 252	10 176	10 998	48 096
Total	9 579	10 298	11 252	11 196	13 037	55 362

Integrated circuit design

In the area of integrated circuit design, indirect R&D support of CZK 59 million was recorded on the basis of an analysis of the financial statements of companies operating in this market segment. Direct support amounted to CZK 66,8 million (Table 6). Direct R&D support in the field of integrated circuit design increased by 278 % in the period under review.

Table 6: Total direct support in integrated circuit design in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
MIT	232	0	0	378	605	1 215
MOE	0	6 191	10 090	10 028	7 941	34 250
TA ČR	3 217	8 320	6 734	7 786	5 236	31 293
Total	3 449	14 511	16 824	18 192	13 782	66 758

According to the data, direct R&D support is mainly used by those who program field gate arrays (FPGAs). Designers of other types of integrated circuits predominantly use indirect public R&D support.

In terms of the distribution of aid between private enterprises and public research organisations, 39 million was allocated to private enterprises and 28 million to research organisations.

Radiation resistant electronics

191 million crowns were allocated to radiation resistant electronics (Table 7). The largest allocations were made in 2018 and 2019, but these figures are affected by the funding of the Centre of Competence on Advanced Detection Systems for Ionising Radiation, whose funding was discontinued in 2019.

Table 7: Total direct support in the field of radiation-hardened electronics in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
MIT	20 174	24 317	29 615	11 337	6 323	91 766
MOE	2 572	643	0	0	0	3 215
TA ČR	33 221	35 468	8 961	9 018	9 262	95 930
Total	55 967	60 428	38 576	20 355	15 585	190 911

In terms of the distribution of the allocation to public research organisations and private enterprises, CZK 90.5 million was allocated to public research organisations (of which CZK 13.3 million to teaching hospitals) and CZK 100.5 million to private enterprises.

Housing area

Grants totalling CZK 41.3 million were awarded in the area of housing (Table 8). The highest financial allocation was again recorded in 2020 (CZK 12 million). Thereafter, there was a reduction to CZK 6.8 million (a decrease of 43.9%).

Table 8: Total direct support in the area of housing in thousands of CZK (own)

Provider	2018	2019	2020	2021	2022	Total
GA CZECH REPUBLIC	4234	2213	2227	0	0	8 674
MIT	4 631	4 463	4 294	0	0	13 388
TA ČR	0	0	5 541	6 910	6 769	19 220
Total	8 865	6 676	12 062	6 910	6 769	41 282

Direct public support for research and development in the amount of CZK 20.1 million was allocated to research organisations. CZK 21.2 million to private enterprises.

Area of suppliers

The allocation of direct public support to suppliers of equipment and materials for the production of semiconductor components is estimated at CZK 1 billion (Table 9). The highest aid was recorded in 2020 (CZK 293.1 million), followed by a decrease to CZK 150.6 million in 2022, a decrease of 48.6%.

In terms of the distribution of the financial allocation between public research organisations and private enterprises, CZK 721.2 million was allocated to public research organisations and CZK 349.2 million to private enterprises. The allocation is considerably increased by the Centre for Electron and Photon Optics, which was allocated CZK 334.6 million from the programme for the support of applied research, experimental development and innovation of the National Centre of Competence in the reporting period.

Table 9: Total direct support to suppliers in thousands CZK (own)

Provider	2018	2019	2020	2021	2022	Total
GA CZECH REPUBLIC	5 413	5 916	5 585	6 046	5 199	28 159
MIT	23 838	23 126	23 079	19 031	16 015	105 089
MOE	31 354	46 955	43 137	28 258	17 145	166 849
TA ČR	102 605	174 430	221 300	159 710	112 264	770 309
Total	163 210	250 427	293 101	213 045	150 623	1 070 406

However, the area of suppliers is specific in that the total allocation cannot be included only under the semiconductor sector, as supplies are also made to other sectors of the economy. In particular, research in the area of optical devices (including electron microscopes), materials used in the semiconductor sector and vacuum systems have been included in the suppliers' area.

Within the value chain, unspecified research

Support for large research infrastructures has been included in unspecified research. In addition, the Flexible Printed Microelectronics using Organic and Hybrid Materials Competence Centre, support for basic research projects for which a specific application is not yet apparent and the Spintronics Centre.

A total of CZK 855.4 million was allocated to these projects (of which approximately CZK 497 million was allocated to large research infrastructure projects). 193 million CZK were allocated to basic research projects supported by the Grant Agency of the Czech Republic (Table 10).

The vast majority of the allocation (92.7%) was allocated to public research organisations. The total amount was CZK 793.3 million. CZK 62 million was allocated to private enterprises.

Table 10: Total direct support for unspecified research in thousands CZK (own)

Provider	2018	2019	2020	2021	2022	Total
GA CZECH REPUBLIC	34 293	44 745	35 111	39 343	39 482	192 974
MIT	4045	4552	4559	0	0	13 156
MOE	104 224	102 226	123 938	122 020	102 194	554 602
MV	6 337	3 491	0	0	0	9 828
TA ČR	22 667	28 438	16 757	14 636	2 356	84 854
Total	171 566	183 452	180 365	175 999	144 032	855 414

Overall support for individual parts of the value chain

Table 11 shows the total support to the semiconductor sector across the two dimensions. Specifically, the dimension of position in the value chain and the dimension of entity type. The table shows that despite the relatively large financial allocation to the semiconductor sector, public support for R&D in the parts of the value chain closest to the final product launch (development of a commercializable semiconductor technology solution) is itself marginal.

Table 11: Total direct support for R&D in thousands CZK (own)

Type of entity / position in	Private enterprise	Public research organisation	Total sum

the value chain	Direct	Indirect	Universities and Institutes of the CAS	Hospital	
Unspecified research	62 068		793 346		855 414
Design	1 215	58 688			59 903
Design - FPGA	37 740		27 803		65 543
Suppliers	349 203		721 203		1 070 406
Housing	21 188		20 094		41 282
Radiation resistant electronics	100 435		77 153	13 323	190 911
Production	55 362		29 210		84 572
Total sum	627 211	58 688	1 668 809	13 323	2 368 031

Conclusion of the analysis

1) The funds are mainly directed towards basic research and research into suppliers of equipment and materials for the production of semiconductor components.
2) Public support for R&D in the parts of the value chain closest to the final product launch (development of a commercializable solution in semiconductor technology) is marginal.
3) In most of the monitored areas, there was a decrease in financial allocation in 2021 and 2022.

Annex 10: Total costs associated with the strategy

Annex 10 shows the total estimated maximum costs associated with the implementation of the National Semiconductor Strategy. Table 1 specifically lists these costs by measure.

Table 1: Total estimated maximum costs associated with the implementation of the National Semiconductor Strategy by measure (own)

Measures	2024	2025	2026	2027	2028	2029	Sum
Task 1.1. A							0,00 mil. CZK
Task 1.1. B		25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK		100,00 mil. CZK
Task 1.2.A*							0,00 mil. CZK
Task 1.2.B*		50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	250.00 miles. CZK
Task 1.2.C*							0,00 mil. CZK
Task 1.2.D*			375,00 mil. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	450,00 mil. CZK
Task 1.3.A**		33,00 mil. CZK	1 276,00 mil. CZK	2 828,00 mil. CZK	9 863,00 mil. CZK	6 000,00 mil. CZK	20 000,00 miles. CZK
Task 1.4. A							0,00 mil. CZK
Task 1.5. A							0,00 mil. CZK
Task 1.5. B		1,00 mil. CZK					1,00 mil. CZK
Task 2.1. A	0,03 mil. CZK						0,03 mil. CZK
Task 2.2. A	0,03 mil. CZK						0,03 mil. CZK
Task 2.3. A	0,03 mil. CZK						0,03 mil. CZK
Task 2.4. A		12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	60,00 mil. CZK
Task 3.1. A			150.00 miles. CZK	150.00 miles. CZK	150.00 miles. CZK	150.00 miles. CZK	600,00 mil. CZK
Task 3.2. A		35.50 miles. CZK	101.50 million. CZK	97,00 mil. CZK	51.50 million. CZK	64.50 million. CZK	350.00 miles. CZK
Task 3.3. A		50.00 miles. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	250.00 miles. CZK
Task 4.1. A							0,00 mil. CZK
Task 4.1. B							0,00 mil. CZK
Task 4.2. A		0,35 mil. CZK					0,35 mil. CZK
Task 4.2. B			25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	100,00 mil. CZK
Task 4.3. A		0,35 mil. CZK					0,35 mil. CZK
Task 4.3. B			25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	25.00 miles. CZK	100,00 mil. CZK
Task 4.4. A							0,00 mil. CZK
Task 4.4. B							0,00 mil. CZK
Task 4.5. A			0,35 mil. CZK				0,35 mil. CZK
Task 4.5. B			3.75 million. CZK	3.75 million. CZK	3.75 million. CZK	3.75 million. CZK	15.00 miles. CZK
Task 4.6. A			5,00 mil. CZK	5,00 mil. CZK	5,00 mil. CZK	5,00 mil. CZK	20.00 miles. CZK
Task 4.6. B			0,80 mil. CZK	0,80 mil. CZK	0,80 mil. CZK	0,80 mil. CZK	3.20 million. CZK
Task 4.6.C			3.20 million. CZK	3.20 million. CZK	3.20 million. CZK	3.20 million. CZK	12.80 million. CZK
Task 4.7. A			20.00 miles. CZK	20.00 miles. CZK	20.00 miles. CZK	20.00 miles. CZK	80,00 mil. CZK

Task 5.1. A	0,15 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	0,30 mil. CZK	1.65 million. CZK
Task 5.2. A		50.00 miles. CZK	50.00 miles. CZK	50,00 mil. CZK	50,00 mil. CZK	50,00 mil. CZK	250.00 miles. CZK
Task 5.3. A		4,00 mil. CZK	4,00 mil. CZK	4,00 mil. CZK	4,00 mil. CZK	4,00 mil. CZK	20.00 miles. CZK
Task 5.4. A							0,00 mil. CZK
Task 5.4.B* **	220,00 mil. CZK	440,00 mil. CZK	440,00 mil. CZK				1 100,00 mil. CZK
Task 5.4.C							0,00 mil. CZK
Task 5.4. D				200,00 mil. CZK	200,00 mil. CZK		400,00 mil. CZK
Task 5.5. A	0,20 mil. CZK	0,40 mil. CZK	0,40 mil. CZK				1,00 mil. CZK
Total	220.43 million. CZK	701.90 million. CZK	2 617.30 million. CZK	3 574.05 million. CZK	10 563.55 million. CZK	6 488.55 million. CZK	24 165.78 million. CZK
Total in €	9 million. €	28 miles. €	105 miles. €	143 miles. €	423 miles. €	260 miles. €	967 miles. €

* These costs are not associated with the implementation of Option I.

** This is the maximum commitment from the existing budget for investment incentives. It does not have to be exhausted.

*** The required funding is already part of the state budget and its medium-term outlook or the National Recovery Plan (NRP)

Table 2 then shows the total maximum projected costs for each strategic objective. The baseline option without pilot line support (Option I) has a total projected cost of CZK 23 656.34 million.

Table 2: Total estimated maximum costs associated with the implementation of the National Semiconductor Strategy by strategic objective (own)

Target	2024	2025	2026	2027	2028	2029	Sum
Strategic Objective 1	0,00 mil. CZK	109,00 mil. CZK	1 726,00 mil. CZK	2 928,00 mil. CZK	9 963,00 mil. CZK	6 075,00 mil. CZK	20 801,00 mil. CZK
Strategic Objective 2	0,08 mil. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	12.00 miles. CZK	60.08 million. CZK
Strategic Objective 3	0,00 mil. CZK	85.50 million. CZK	301.50 million. CZK	297,00 mil. CZK	251.50 million. CZK	264.50 million. CZK	1 200,00 mil. CZK
Strategic Objective 4	0,00 mil. CZK	0,70 mil. CZK	83.10 million. CZK	82.75 million. CZK	82.75 million. CZK	82.75 million. CZK	332.05 million. CZK
Strategic Objective 5	220.35 million. CZK	494.70 million. CZK	494.70 million. CZK	254.30 million. CZK	254.30 million. CZK	54.30 million. CZK	1 772.65 million. CZK
Total	220.43 million. CZK	701.90 million. CZK	2 617.30 million. CZK	3 574.05 million. CZK	10 563.55 million. CZK	6 488.55 million. CZK	24 165.78 million. CZK

Under strategic objective 1, this concerns costs associated with the implementation of the European Regulation (Chip Act). Twenty billion CZK of this is earmarked for investment incentives for strategic investment actions in the semiconductor sector. These investment incentives will, in accordance with the current legislation, be subject to government approval and therefore the entire amount may not be allocated. The remaining CZK 801 million is earmarked for the national co-financing of a competence centre to be established under the Chip Act worth CZK 100 million, CZK 700 million for a pilot line programme and CZK 1 million for measures related to monitoring and crisis management in case of shortages of semiconductor components. However, in the baseline option (Option I), CZK 700 million will not be spent because this option does not foresee national co-financing of the pilot lines programme. Costs under the strategic objective are spent to maximise spill over effects from European initiatives.

CZK 60.08 million has been allocated for strategic objective 2, which is focused on export promotion. The vast majority of the funds under this objective (CZK 60 million) go to support the participation of Czech entities in international fairs, conferences and exhibitions. The rest of the funds (around CZK 75,000) are earmarked for the preparation of documents for CzechTrade, CzechInvest, economic diplomats and scientific diplomats. These costs are spent because of the desirable diversification of the market and exports of the Czech Republic.

Under Strategic Objective 3, which is aimed at supporting research and development, the total allocation is planned at CZK 1 200 million. The costliest measure under this objective is the dedicated support for excellent research teams, totalling CZK 600 million. In addition, CZK 350 million is earmarked to support cooperation between the academic sector and industry under the Sigma programme of the Czech Technology Agency and CZK 250 million is earmarked to support industrial research under the TWIST programme administered by the Ministry of Industry and Trade of the Czech Republic. These costs are spent to stabilise cutting-edge research and to support applied research linked to technology transfer from academia.

The fourth strategic objective focuses on developing the available workforce and talent. A total of CZK 332.05 million is allocated to this strategic objective. CZK 100 million is allocated to support the promotion of STEM fields. 100 million is allocated to support relevant programs at universities. 131 million is allocated for attracting foreign workforce. The remainder of the cost is made up of programme preparation costs. These costs are being spent because of a shortage of around 5,000 workers missing from the labour market.

CZK 1,772.65 million is planned to be allocated for measures to meet the fifth strategic objective, "support for entrepreneurship". The highest amount, CZK 1 500 million, should be spent on direct support for four projects notified to the European Commission under IPCEI Microelectronics and Communication Technology. CZK 250 million is planned to be allocated to support start-up companies, CZK 20 million should be spent to support Czech subcontractors within the semiconductor sector, CZK 1 million to develop regional ecosystems and CZK 1.65 million should be spent to provide an expert working group to help identify and approach interesting foreign investors within the semiconductor sector. The aim of these measures is to raise the level of GDP in the Czech Republic.