(Candidate) IPCEI on Advanced Semiconductor Technologies - Central narrative

- Megatrends such as Artificial Intelligence, Automation, Security and Sustainability will fundamentally change society. **The European semiconductor industry will play a vital role in this transformation if, and only if, we urgently adopt a collective and ambitious approach** to seize these market opportunities.
- Although the European semiconductor industry has major strengths in specific technological fields, it has been under pressure for the past 20 years. **Semiconductors more and more are a key domain of global geo-economic and political dominance**, reinforcing the need for European technological sovereignty and strong position on global markets.
- **To face this in-depth transformation, an IPCEI focused on Advanced Semiconductor Technologies will provide the necessary impulse for Europe's semiconductor industry** to capitalize on emerging technological opportunities to establish new positions of global leadership and market strength.
- The IPCEI AST answers to these challenges by addressing six technology fields: **AI Chips and Accelerators; Chiplets and Heterogeneous integration/Advanced Packaging; Photonic Integrated Circuits; Disruptive Sensors for Automation; Power Electronics and Disruptive Energy Saving Solutions; and Secure Communication, including enabling technologies.**
- To ensure its success, the IPCEI-AST will build on the efforts made through already existing EU initiatives, especially the pilot lines, to accelerate industrial R&D and first industrial deployment.

The Importance of Semiconductors

Semiconductors are the backbone of our future economy. They are embedded in virtually every electronic device and essential to a wide range of applications and end markets. The importance of semiconductors is only expected to increase over the coming decade, **driven by megatrends such as Artificial Intelligence, Automation, Security and Sustainability.**

Semiconductors are more than just enablers – they are becoming a central driver of economic growth and prosperity. **The semiconductor industry is expected to reach €1 trillion EUR in annual revenue by 2030 and may double again by 2040**[1]. It enables end products across a wide range of industries – from automobiles, via industrial equipment and IT services, to energy technologies – multiplying the impact of semiconductors in Europe's GDP and infrastructure. Semiconductors form the basis for roughly half of the global GDP. At the same time, the dynamics of the semiconductor industry are undergoing rapid transformation: **semiconductors have emerged as a key domain of global geo-economic competition**. As access to (advanced) semiconductors directly impacts industrial and security capabilities, countries across the globe are **mobilizing significant resources to invest in their domestic semiconductor industries**. Substantial investments are being made toward expanding production capacity and accelerating R&D as well as to "home-shore" strategically important production, with the goal of **creating global champions.** Also, Europe needs to aim at building up positions within the global supply chains on which European players will become indispensable. On some fields like manufacturing semiconductor equipment (for example lithography tools) or sensors, power electronics, Europe has already an indispensable position which has to be sustained. Simultaneously, efforts need to be made to reduce strategic dependencies on foreign suppliers to increase supply chain resilience and security in crucial domains such as infrastructure and defence.

[1] 2025 semiconductor industry outlook | Deloitte Insights

Thus, the challenge Europe is facing in this domain is threefold: 1) To increase the **resilience** of supply regarding today's and tomorrow's European semiconductor demands while anticipating demand shifts triggered by the mentioned megatrends, 2) to increase **security** of semiconductor solutions taking into account new geopolitical realities, and 3) to achieve and sustain **technological leadership** over strategic semiconductor-enabled technologies and supply chains leveraging Europe's excellent R&D&I capabilities.

The Complexity of the Global Semiconductor Ecosystem

The global semiconductor supply chain is highly complex and intricate. Semiconductor production consists of numerous highly specialized steps, each requiring its own chain of suppliers. Most of the stages of the supply chain are nowadays dominated by only a select number of players, due to very large investments in technological innovation and production capacity, regional specialization and significant economies of scale. Companies typically concentrate on specific steps of the supply chain, and within those steps on specific market segments or technological niches where they can achieve global leadership.

These economies of scale, combined with high capital requirements and steep requirements in technological expertise, make the semiconductor market difficult to enter. **Entry is only possible through a combination of disruptive innovation that outperforms existing solutions and the ability to rapidly bring these innovations to market while scaling up production to meet market demand. Additionally, the introduction of incremental innovations can also lead to market capture by capitalizing on sudden novel market demands**.

Over the past decades, globalization and the drive for cost efficiency have led to a shift in production capacity to regions with the most favourable conditions – primarily in Asia. This trend has also influenced the European economy, since many European companies have relocated parts of their manufacturing activities abroad. Meanwhile, Europe has remained a global leader in R&D, supported by its excellent research institutions and robust knowledge infrastructure.

The Need for Strategic Choices

Europe's position in the global semiconductor industry has been under pressure for the past 20 years. This pressure has only increased in recent years, as semiconductors have become a central focus of geopolitical competition. Countries around the world are rapidly scaling up investments in R&D and manufacturing capacity as they strive to increase their technological capabilities. Although Europe has also mobilized investments in production capacity and further innovations through the Chips Act, earlier IPCEIs, and other policy initiatives, these efforts have not been enough to catch up. Europe cannot afford to fall further behind in such a strategically vital sector. **Yet the global competition is intense, and success requires a continuous clear focus and coordination**. The current geopolitical context and the uncertainty it creates calls for determined and collective action to ensure that Europe maintains and gains market leadership in the microelectronics industry and the European industry in general.

Thanks to its world-class R&D ecosystem and its strong foothold in key segments of the global supply chain, Europe has a solid foundation to build upon. However, it is not realistic to aim for leadership across the entire semiconductor value chain**. Instead, Europe must concentrate its efforts to secure and expand positions of global relevance and excellence, while reducing critical dependencies.** Rather than attempting to imitate the competition and trying to catch up, Europe should **build upon existing strengths to leapfrog and get technologically ahead of the competition**.

If Europe's efforts are too fragmented, it risks spreading its resources too thinly – and losing momentum in the areas where it could lead.

At the same time, **the emergence of new technological areas and disruptive innovation in established areas are expected to become increasingly important in the semiconductor value chain** in the coming

years for the next generation of semiconductor innovation. **Strategic choices made today will determine Europe's role in shaping these future breakthroughs,** thereby facilitating continued economic prosperity and increase living standards across Europe.

Building on earlier European initiatives on semiconductors

Through the **European Chips Act**, Europe has set itself an ambitious target to bolster European competitiveness and resilience in semiconductor technologies and applications. To this end, pillar I of the European Chips Act aims at supporting technological capacity building and innovation in the EU by bridging the gap between the EU's advanced research and innovation capabilities and their industrial exploitation. In particular, the pilot lines constitute a promising accelerator to bring technologies developed through upstream research closer to industrialization. Furthermore, in setting up semiconductor competence centres in the Member States the EU will follow its ambition to provide easy access to technical expertise and experimentation in the area of semiconductors. This will help companies, SMEs in particular, to approach and improve design capabilities and developing skills. Also, the establishment of the design platform created in an open, non-discriminatory and transparent way, will stimulate wide cooperation between users and key actors of the ecosystem whilst reinforcing Europe's advanced chip design capacity. **It is essential that the (candidate) IPCEI-AST aligns seamlessly with and capitalizes on the initial efforts made through the pilot lines and the other mentioned EU's initiatives and beyond, to accelerate industrial R&D and first industrial deployment.** This IPCEI will also create synergies with the approved IPCEIs on Microelectronics (ME) and Microelectronics and Communication Technology (ME/CT), striving to make the European semiconductor ecosystem ready for the next generation of semiconductor technologies.

Goal of the (canditate) IPCEI Advanced Semiconductor Technologies

An IPCEI focused on Advanced Semiconductor Technologies will provide the necessary impulse for Europe's semiconductor industry to capitalize on emerging opportunities to establish new positions of global technological leadership and market strength. **Megatrends such as Artificial Intelligence, Automation, Security and Sustainability** continue to accelerate, leading to a fundamental transformation of the semiconductor industry as well as addressed downstream industries and causing new innovation and market opportunities to emerge**. As an integrated project**, IPCEI AST will involve Member States and participants that will commit to contribute to the project by aligning on strategic technological areas, developing innovative technologies and investing large efforts **to make sure that Europe capitalizes on these new opportunities, and supports at the appropriate level the transition from cutting-edge semiconductor research into viable, market-ready products and production processes.**. Furthermore, the aggregation of an elevated number of participants, with different backgrounds and expertise, coming from industry and R&D, will contribute to the development of an highly innovative EU semiconductor ecosystem able to address the most strategic requirements of the EU industrial sectors boosting the EU's competitiveness and resilience.

Sub goals:

- **Bridge the gap from lab to fab:** Turn Europe's world-class semiconductor research into business impact by accelerating first industrial deployment and prepare the scale-up of production capacity. This includes leveraging existing pilot lines that have been set up in Europe under the Chips Act.
- **Prepare for the next generation of semiconductor technologies:** Reflect demand shifts resulting from emerging megatrends by driving innovation in future-critical semiconductor technologies, while at the same time advancing Europe's strategic goal of technological leadership and security.
- **Establish indispensable European strategic control points:** Strengthen Europe's strategic position by building upon its strengths to create new indispensable positions in the global value chain.

- **Reinforce ecosystem resilience:** Reduce undesirable strategic dependencies by developing competitive European alternatives and creating a strong value chain around it.
- **Strengthen downstream industries:** Strengthen the competitive edge of European companies by providing cutting-edge semiconductors components tailored to end-user industries' future needs.
- **Solve Market Failures:** Resolve systemic coordination challenges and unlock private investments in areas with strong innovation potential and vast spillover effects.

Logical Framework of the (candidate) IPCEI Advanced Semiconductor Technologies

The logical framework of the IPCEI-AST will be structured along four levels:

1. The central narrative, providing the overarching goals of the IPCEI.
2. The dominant megatrends that form the backdrop influencing the semiconductor industry in the coming years.
3. The workstreams that can be identified as cross-cutting themes.
4. The work packages that describe which technologies are relevant in this context.

Chosen focus areas for the (candidate) IPCEI-AST

Given the need for strategic choices described above, this IPCEI will focus on a select number of technology fields. These technology fields were the result of an extensive process of identification and refinement with input from industry and Member States, and were chosen based on factors such as their contribution to European security and resilience, competitiveness, spill-over effects, among others, as well as their suitability to the IPCEI requirements. The technology fields are the following:

Emerging technology areas:

The three emerging technology areas are areas that are expected to take on a significant share of the semiconductor industry's strategic relevance in the future. These areas present key opportunities for Europe to strengthen its position in the global semiconductor landscape. The emerging technology areas are:

- AI Chips and accelerators
- Chiplets and Heterogeneous integration / Advanced Packaging
- Photonic Integrated Circuits

Established technology areas:

In these technology areas, Europe currently holds a solid and strong position. Although these areas are well-established, targeted innovation efforts can unlock new potential, drive significant breakthroughs and create new market opportunities. It is important to note that not all developments within these technology areas automatically fall within scope. Technological development must contribute to the goals as formulated in the narrative. The established technology areas are:

- Disruptive sensors for automation
- Power electronics and disruptive energy saving solutions
- Secure communication

Enabling technologies:

Enabling technologies are overarching technologies within the value chain essential to achieving the developmental goals for the above-mentioned technology areas. Any technology that strengthens Europe's position within the value chain, relevant to the development of the aforementioned technology areas is considered within scope. This includes technologies that may not fall directly within the core areas

themselves but are essential for their development and competitiveness. Furthermore, the enabling technologies also include application domains that may not be immediately relevant within the European context, but that are strategically important for Europe's position in the global value chain. The enabling technologies are (not exhaustive):

- EDA tools, Semiconductor equipment, wafer and materials.

The technology fields will contribute to address the megatrends and form the basis of the to be determined workstreams. They will lay the basis for further deep-dives on how – by aligning and bundling strengths – new European positions of global technological leadership, market strength and resilience can be built.