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THE EU'S STRATEGIC ROLE IN THE GLOBAL SEMICONDUCTOR SUPPLY CHAIN AND ITS IMPLICATIONS FOR CLEAN ENERGY

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The EU's Strategic Role in the Global Semiconductor Supply Chain and its Implications for Clean Energy

As our global economy becomes increasingly digital, AI-driven, and reliant on 5G networks, the demand for semiconductors will only continue to surge. These components are not only fundamental to technological advancement but crucial for geopolitical stability. The global semiconductor supply chain represents a critical battleground with far-reaching implications for economic stability, national security and the transition to clean energy. Despite the EU's significant role in this supply chain, it still lags behind key global competitors. Taiwan and China dominate the manufacturing market, while the US leads in chip design innovation, each controlling different segments of the supply chain. To navigate this complex landscape, the EU must strengthen its relationships with East Asia's semiconductor leaders — China, South Korea and Taiwan — whilst leveraging international agreements such as the ones discussed during the recent Japan–US semiconductor summit. By strategically positioning itself in the global semiconductor supply chain, the EU can secure its technological future and play a pivotal role in the global shift towards sustainable energy solutions.

In view of rising geopolitical tension, semiconductors are increasingly strategically important. Not only are semiconductors at the centre of industries such as automotive, telecommunications and consumer electronics, they are also relevant components of national security strategies, with military powers becoming increasingly digitised. Furthermore, they are a key driving force towards achieving global climate goals as the building blocks of most clean energy technologies, such as electric vehicles, wind turbines and solar panels. The challenge, however, lies in the production of semiconductors, which use copious amounts of energy and water at significant environmental cost. It is imperative to integrate more sustainable standards into the industry's manufacturing processes by utilising the potential benefits of clean energy.

The semiconductor supply chain is intricately interconnected on a global scale, meaning that any alterations to it will have far-reaching international consequences. Different countries and companies have expertise in distinctive fields and segments of the supply chain, which benefits semiconductor quality. 90% of the world's manufacturing of advanced semiconductors is located in Taiwan, emphasising the world's rigidity in this field. In order to reduce external dependencies, the EU introduced the European Chip Act in September 2023 to ensure that it meets its target of doubling its global market share in semiconductors to 20%. However, this will not come easy. With the sensitive nature of critical raw materials, advanced technologies and extreme precision involved during production, challenges remain abundant.

The EU's Stance On Semiconductors

The increasing demand for customisation, connectivity and smart devices has significantly

boosted the need for electronic components across a wide array of products, from coffee machines to pacemakers. This surge in demand has elevated the importance of semiconductors in the development of the global economy. Despite the importance of semiconductors, the EU has been lagging behind other global powers in capturing a share of the semiconductor market. To address this gap and achieve its goal of capturing 20% of the global semiconductor market by 2030, the EU has introduced the European Chips Act. This legislation outlines five key objectives: strengthening research and technological leadership; enhancing Europe's capacity to innovate in chip design, manufacturing, and packaging; establishing a framework to boost production by 2030; addressing skills shortages and attracting new talent; and developing a comprehensive understanding amongst member states of global semiconductor supply chains.

To achieve this goal, the EU has outlined three key pillars to strengthen its semiconductor industry and ensure global resilience and competitiveness. The first pillar, the "Chip for Europe Initiative" aims to support large-scale technological capacity building and innovation. This initiative focuses on the development and deployment of next-generation semiconductors, for instance, investing in talent and further education to improve its high-level technology department. The second pillar establishes a framework to safeguard the supply chain resilience of the EU semiconductor sector. This includes implementing policies in order to reduce foreign dependency and mitigate supply chain disruptions, while developing strategies to ensure the continuity of semiconductor supply. The third pillar involves the creation of coordination mechanisms between EU member states and the European Commission, monitored by the European Semiconductor Board.

Germany is considered to be one of Europe's most hopeful locations for the innovation of semiconductor development. Germany's 2021 government report demonstrates that achieving 20% of global semiconductor production is a top priority. Key to achieving its production objectives is a TSMC factory in Dresden, responsible for cutting-edge silicon carbide and gallium nitride semiconductors production. These are particularly useful for electric vehicles and renewable energy products. Germany is considered an attractive investment location across Europe as the state of Saxony provides multiple subsidies to its key industries and most relevant factories, making it a technologically friendly investment environment.

The most prominent European name in the semiconductor world is ASML in the Netherlands. Being the only company in the world producing extreme ultraviolet lithography machines, which are used by the most advanced semiconductor firms like Samsung and TSMC, makes the Netherlands a fundamental link within the global supply chain.

The EU has made strides towards greater autonomy in the semiconductor supply chain with the introduction of the European Chip Act. However, significant vulnerabilities remain. In late 2023, the US struck a deal with ASML to block chip exports to China, excluding the EU from negotiations. This unilateral action by the US, without EU involvement, undermines the European Commission's authority and could provoke retaliatory measures from China against other European

countries, potentially igniting a broader chip trade war. This situation highlights the EU's difficulties and inefficiencies in policy implementation, as foreign policy agreements typically take years to finalise. It serves as a wake-up call for the EU to adapt more swiftly to market controls implemented by other powers and streamline its decision-making processes, especially in a rapidly changing and increasingly hostile global environment.

Overall, this international involvement in Europe underscores the profound interconnectivity between nations in the semiconductor supply chain. Any adjustment in production and consumption can significantly impact a country's economy, thereby influencing broader global objectives such as carbon neutrality.

The role of semiconductors in clean energy

The elevation of climate change as a global concern is reflected in the increased demand for semiconductors, as they are essential for the deployment of clean energy technologies. However, the current process of semiconductor manufacturing is not sustainable. As they are a key element in the development of solar, wind and other miscellaneous energy infrastructure, it is essential to ensure they are themselves produced in a sustainable manner. A Harvard study showed that around 75% of the CO2 emissions for battery-powered devices take place during the manufacturing process. It is therefore crucial for chipmakers to operate using sustainable production methods and maintain overarching green energy targets like achieving net-zero emissions by 2030. One increasingly popular approach to enhancing the sustainability of semiconductor manufacturing is the adoption of renewable energy methods, such as utilising solar power from electrical utilities.

The semiconductor supply chain is heavily dependent on water, particularly for the purification of semiconductors. Electrodeionization, which uses electrical currents to remove ions and produce high-purity water, is a key industry process. In 2019, approximately one trillion litres of water were consumed during semiconductor manufacturing. This staggering figure has highlighted the urgent need for companies to reduce water consumption and find sustainable methods for water storage and recycling.

Water scarcity has intensified this urgency, especially in Taiwan, where high water stress is prevalent. In response, Taiwan has implemented various water-saving measures, achieving a water recycling rate of over 85% from 2016 to 2020. These measures include harvesting rainwater, improving the efficiency of existing facilities, constructing backup water supply networks and involving the private sector in desalination.

Companies like Intel have also adopted comprehensive water management practices, aiming to restore and return more freshwater than they consume. These efforts are part of a broader goal to achieve a net-positive global water contribution, ensuring sustainable water usage in the semiconductor industry. Moreover, the focus on water efficiency not only addresses environmental concerns but also aligns with global sustainability goals. By innovating in water management,

semiconductor companies can contribute to broader climate objectives, reducing their ecological footprint whilst maintaining productive efficiency.

However, the use of water is not the only critical element impacting the climate during the semiconductor manufacturing process. The production also releases perfluorocarbons and sulphur hexafluoride, both of which have high global warming potential. Additionally, energy consumption throughout the value chain is a significant concern. By 2030, semiconductor manufacturing is projected to consume 237 terawatt-hours (TWh) of electricity globally, approximately matching Australia's total electricity consumption in 2021. This underscores the urgent need to increase the use of renewable energy sources within the production chain. A life cycle analysis is an efficient way to track effective sustainability strategy implementations that make the manufacturing process more transparent. Further solutions like modern silicon optimise energy efficiency across the entire electrical energy grid. Running a silicon-based industry has many benefits, such as better productivity, cost efficiency, time-to-value and more worker safety through tracking and sensing. It is promising that all the way from energy generation to transmission and storage, semiconductors are the only technology enabling increased efficiency at every link of the supply chain. The goal is to mutually meet local regulatory requirements, remain competitive and gain societal acceptance. Semiconductors are at the centre of the evolving digital economy, shaping general trends and driving the future of manufacturing industries. They facilitate the adoption of energy-saving technologies, as evidenced by the significant decrease in renewable power generation costs over the past decade. In 2020, 62% of total renewable power generation capacity added had lower costs than the cheapest new fossil fuel sources.

How can the EU assert itself in the global semiconductor supply chain?

Incentivising collaboration with East Asian semiconductor giants

One approach the EU could take to assert itself within the global semiconductor supply chain is to enhance joint research initiatives focused on semiconductor research and development (R&D), leveraging support from both EU and East Asian producers in China, South Korea, Japan and Taiwan. Horizon Europe, an EU research initiative tasked with tackling several global challenges, including climate change and cancer treatment would be a good example for such a venture. The initiative is backed by the EU member states, but also by many other non-EU nations in Europe and beyond. In March 2024, South Korea, which champions a sizable technology industry, joined the Horizon Europe initiative. South Korea’s collaboration through this primarily EU-focused framework acts as a potential template for how future semiconductor-focused research initiatives could be established between the EU and other East Asian nations. By exploring an expanded utilisation of the Horizon Europe framework for advanced collaboration in semiconductor innovation, the EU could not only pioneer new semiconductor technology to achieve greater efficiency and green-energy

targets, but could also forge closer ties with its East Asian partners. Since such collaboration is set up as a joint venture, its funding is expected to be a shared effort of the participating members.

Another approach could be to establish patent pools, enabling semiconductor firms from both the EU and East Asia to contribute to and access essential semiconductor technologies. A contemporary example of a patent pool is Via-LA, a company that has pooled some of the most important technology patents, including *5G* and *MPEG* technology. This pool is subscribed and contributed to by many prevalent companies in the technology sector, including Microsoft, Apple and Samsung. Patent pools are considered mutually beneficial as they allow each member to both contribute to patents and access those provided by others. They also reduce the risk of litigation between rivalling companies whilst saving money that would have been required for independent R&D purposes. This approach could be an open project where each member contributes and reaps the gains from the pool, hence funding for the project would — in theory — be a less pressing concern.

Leveraging international agreements in East Asia

The EU could leverage international agreements by focusing on standardisation. By harmonising technical standards and regulatory frameworks, the EU can facilitate smoother trade and enhance collaboration and dialogue with its partners in the semiconductor sector in East Asia. The *Transatlantic Economic Council*, a framework dedicated to increasing collaboration between European and American firms through the harmonisation of standards across a range of industries could serve as a possible model. The benefit of such harmonisation in the semiconductor industry would be to facilitate trade between EU and East Asian semiconductor firms — as well as companies which require regular supply of semiconductors for their products by ensuring continuity between the standards applied. It would also increase interdependence between the two regions, and improve relations in a currently turbulent market. However, despite the urgency to succeed, coordination at such a global scale will be a major challenge, as well as a costly venture. Overall, harmonising all relevant industry standards would be a difficult and time-consuming task and its feasibility would depend on the funding that can be accrued, and the extent to which industry leaders would be willing to cooperate.

The EU could also build on existing platforms, organising high-level semiconductor summits and forums to enhance collaboration. For example, SEMICON Europa in Munich is a yearly summit held to facilitate dialogue between leading semiconductor firms in the EU, like Siemens and imec. This expo is responsible for establishing a mutual, synchronised objective for companies within the semiconductor industry, such as researching sustainable business practices and establishing fail safes for future supply chain disruptions. Through such events the EU and its companies could foster dialogue and understanding between itself and partnered semiconductor firms in East Asia. The overarching objective would be to align strategies to address supply chain disruptions and economic challenges beyond the semiconductor industry, as well as to

facilitate dialogue between policymakers from both the EU and East Asia to create synergies and relevant supportive policies. The benefit would be a harmonisation of industry standards, an increase in interdependence between the two regions, and advancing policies driving the industry forward.

Developing independent semiconductor production in the EU

Given its de-risking policy and aim to reach strategic autonomy, investing in a robust local supply chain for raw materials, equipment and components essential for semiconductor manufacturing will be crucial for the EU to develop independent semiconductor production. The EU should focus on securing sources for essential semiconductor materials, such as silicon and other rare earth elements. An increasingly turbulent semiconductor supply chain environment, relying on foreign import of essential materials, makes the EU vulnerable to any changes or disruptions that currently complicates the East Asian market, like the escalating chip war between the US and China, or previous supply chain suspensions and delays during the covid-19 pandemic. By establishing a more diversified and where possible local supply chain, EU firms can establish themself as independent brokers and develop a more solid semiconductor production.

However, one of the main issues is cost. Semiconductor manufacturing is expensive, raising questions about the feasibility of the EU's ambitious goal of capturing 20% of the global semiconductor market. The EU has already committed 43 billion EUR to its Chips Act, encompassing both public and private investment. Horizon and Digital Europe will provide 3.3 billion EUR of funding. Digital Europe will focus on capacity-building activities, while Horizon Europe will fund related research and innovation initiatives.

The EU's risk of falling behind its global competitors looms large. Since 2014, China is projected to have invested approximately 138 billion EUR into its semiconductor industry. South Korea is currently aiming to invest up to 400 billion EUR by 2030. Meanwhile, the US is investing around 182 billion EUR in its Chips and Science Act, in order to gain a leading position in the industry. An example of this is Intel's construction of the Fab 34 factory in Ireland. This private investment by a US company on European soil highlights the overlapping goals of supply chain resilience between the US and the EU. Intel considers its Irish venture as an opportunity to collaborate with an established financial partner, while the EU benefits from enhanced autonomy in its supply chain, sustainability and technological advancement. Nevertheless, the stark funding gap poses a significant challenge that the EU will need to address sooner rather than later.

The EU should assert itself to become the leading market player in specific essential niches in the semiconductor business. The Chips Act demonstrates the EU's clear targets and determination to compete in this vibrant and developing market. Additionally, maintaining clean energy practices during production and supporting the role of semiconductors in global climate change initiatives are increasingly relevant, incentivizing the EU to collaborate closely with East Asian

manufacturers to address this global issue. As the world becomes increasingly technologically driven, the vital role of semiconductors is more evident than ever. The EU should continue to strategically position itself within the semiconductor market by engaging with current industry leaders and striving to become one itself. Emphasising the development of its leading semiconductor companies in Germany and the Netherlands can enhance the EU's market dominance. However, the EU must also acknowledge the rapidly advancing semiconductor industry in China and maintain close collaboration with key economies like South Korea, Taiwan and Japan.

The EU must carefully consider the vital future role semiconductors will play in environmental terms. Currently, the practices driving the semiconductor industry are environmentally unsustainable. Without innovation, the EU and the wider world could face significant semiconductor shortages. In recent years, semiconductor companies have already made notable improvements in reducing their carbon footprints and water waste. Yet, as semiconductor manufacturing continues to increase in relevance, efforts to ensure the industry's sustainability must be scaled up.

To distinguish itself in this competitive landscape, the EU should leverage its strengths and focus on specific niche areas within the semiconductor supply chain. By strategically allocating EU funds to key players such as imec and ASML, Europe can solidify its position as a key player in advanced chip design and manufacturing equipment. Europe can therefore secure its technological sovereignty and lead the way in developing a more sustainable and resilient semiconductor supply chain for the future

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