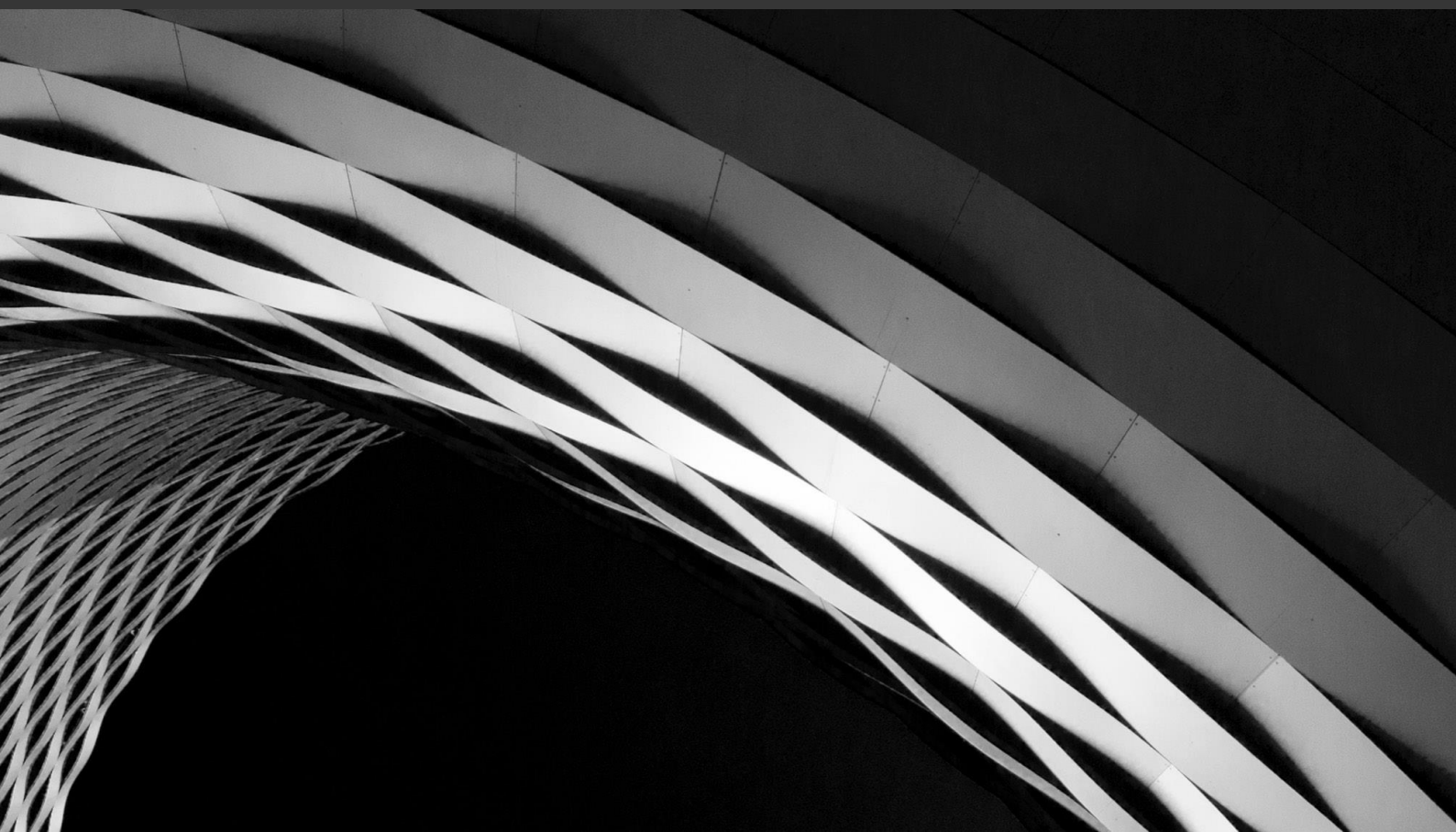
UNLOCKING THE SEMICONDUCTOR PUZZLE

How can Swedish companies navigate and identify opportunities in Taiwan's semiconductor ecosystem



INTRODUCTION

Globally, the semiconductor sector is going through a dramatic transition, with the pandemic showing the acute need for resilient supply chains that can meet demand regardless of external or unforeseen challenges.

The rapid pace of development of new technologies to power a smart future is not slowing down: AI, IoT, High-performance computing (HPC), autonomous driving, and cyber security all remain as focus topics in post-pandemic and the global chip shortages. While we are seeing these impressive innovations and many more being built by advanced semiconductors, another challenge lies ahead: the development of new technologies is not enough, we must also search for sustainable solutions across production processes – from upstream to final products or operations.

It has become increasingly evident that semiconductors are a vital part in our modern digital life with ICT (information and communication technology) products becoming more dependent on semiconductors. Since the early 1980s, Taiwan has been known as one of the world's major ICT markets, and in more recent times, its significant role in the semiconductor value chain.

Within Taiwan, companies are keen to look for new innovative solutions, and the Taiwanese government has announced industrial development policies and research investment support to facilitate development.

Taiwan is an island which has great potential for renewable energy resources, such as geothermal and offshore wind power. The semiconductor ecosystem understands that the future must be powered sustainably, and the Taiwanese policy statement *Carbon Neutrality by 2050* and the global initiative *RE 100* (using 100 per cent renewable energy for production) has set out clear goals for the industries. Environment, social and governance (ESG) regulations are now implemented in the operations of most companies and the semiconductor ecosystem is taking its responsibility towards the future seriously, making contributions to achieving the climate goals.

This report summarises the market trends of Taiwan's semiconductor industry, the ecosystem dynamics, and the potential opportunities for Swedish companies to contribute with sustainable solutions.

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TOWARDS A SMART FUTURE

Taiwan's semiconductor clusters started emerging in the early 1980s. The Taiwan Semiconductor Manufacturing Co Ltd (TSMC) created the foundry service business model that changed the game of semiconductor manufacturing, paving the way for the fabless IC design houses that have become the new super stars. If Taiwan was to stop chip production for a year, the global ICT market would lose USD 500 billion.

THE WORLD'S SEMICONDUCTOR HUB

Since TSMC revolutionised the global semiconductor industry with the foundry model, Taiwan has gradually become a crucial strategic partner in the global supply chain.

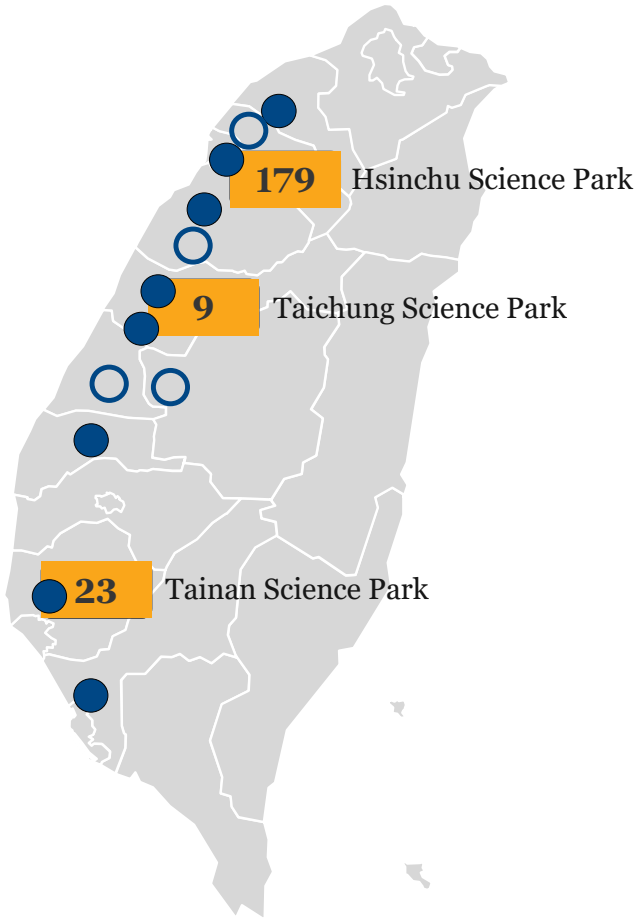
Taiwan has one of the most competitive semiconductor markets in the world with 20 per cent global market share in IC design, 60 per cent in foundry, and 55 per cent in outsourced semiconductor assembly and test (OSAT). Additionally, Taiwan has the largest printed circuit board (PCB) industry in the world, with over 30 per cent market share and internationally recognised OEM/ODM and electronics players, which again consolidate the dominance. Today, over 90 per cent of the world's most advanced chips are manufactured by the Taiwanese foundries.

HOT SPOT FOR ADVANCED TECHNOLOGY INVESTMENTS

The market value of the Taiwanese semiconductor industry reached USD 174 billion in 2022, and the growing market has attracted numerous international suppliers to expand their investments in Taiwan.
These include:

- Merck from Germany with an investment of USD 570 million to install its first mega site in Taiwan
- ASML from the Netherlands is operating its first EUV training centre in Taiwan, following a USD 11 billion investment in 2024

Taiwan's semiconductor clusters



IC manufacturers

- **179 - Hsinchu**
- **9 - Taichung**
- **23 - Tainan**

- US company Micron will expand the investments with USD 150 billion in the next ten years and build its dynamic random-access memory (DRAM) centre in Taiwan.

Taiwan's open and complete semiconductor value chain is attracting global top players in the world to choose Taiwan as their next investment and production destination.

A plan to roll out official polices regarding tax incentives, talent recruitment programmes, and R&D investment benefits has been in place since 2022 and will continue until 2027, all with the goal of creating a high-quality investment environment for the semiconductor industry.
These chip-related acts support the semiconductor industry, and together with the *Net Zero 2050* strategy, officials aim to facilitate the semiconductor ecosystem in Taiwan to transition to sustainable production without losing its advanced position.

FAST AND DYNAMIC, COMPETE AND COLLABORATE

Since their emergence in the 1980s, Taiwan's semiconductor clusters have benefited from increased globalisation with material supply coming from Japan and equipment supplies from the US and Europe. But now, as the process flow and chip designs become increasingly complex, the ecosystem must expand to develop advanced technologies for the both the increased number and complexity of products that require them. From the upstream to the downstream, companies in Taiwan work together to create positive competition: across the value chain, stakeholders can focus on their expertise, share the profit, and develop the industry together.

"Without strategy, execution is aimless. Without execution, strategy is useless."

Dr Morris Chang
Founder, TSMC

Given Taiwan's size, it is about ten times smaller than Germany, the clusters are relatively close in proximity to each other; so, while the companies compete, they also share information, and cooperate easily and fast, making the ecosystem dynamic and responsive to

market needs. As new, innovative players join, the whole ecosystem is driven forward, efficiently and swiftly. The development of foundries, IC design and outsourced semiconductor assembly and test (OSAT) in Taiwan are of great importance to a large part of the world's digital roadmap.

Global semiconductor market value 2022 (in USD billion)

2022	Taiwan	Global	TW's market share	TW's position	Companies in TW	Companies in global
IC (total)	174	574.1	22.3 %	2	TSMC	Intel (US), Samsung (KR)
IC Design			19.2 %	2	MediaTek	Qualcomm (US)
IDM			2.0 %	5	Nanya Tech	Samsung (KR)、Micron (US)
Foundry			62.9 %	1	TSMC, UMC	Global Foundries (US)
OSAT			55.9 %	1	ASE Group	Amkor (US)

The figures above show that the contribution from Taiwan to the global semiconductor market is significant in the whole value chain. Taiwan has a unique role and the leading position in advanced chip manufacturing and packaging. Compared to the ecosystem in South Korea for instance, mostly integrated device manufacturer (IDM), the semiconductor ecosystem in Taiwan is mainly a joint business model: fabless, foundry and packaging-test.

GREAT OPPORTUNITIES FOR SWEDISH COMPANIES

For Swedish companies, there are vast opportunities, but here we dive into three relevant areas with high potential.

1. SUSTAINABILE SOLUTIONS FOR ALL

In March 2022, the *National Development Council Taiwan* officially published *Taiwan's Pathway to Net-Zero Emissions in 2050*, which outlined 12 key strategies to help accelerate the green transition. Semiconductor industries reacted quickly and clearly to show that they are willing to take on responsibility for the green transition and working on their ESG implementation to create more sustainable operations. TSMC, UMC, ACER, and Delta Electronics are the official members of *RE 100*, aiming to reach 100 per cent renewable energy consumption by 2030 / 2050. TSMC was the first semiconductor company to join *RE 100*, working together with its suppliers to reach the sustainability goal of using 100 per cent renewable energy for production. As an example of TSMC's early commitment, the company signed a contract with Ørsted Taiwan for 920 MW offshore wind power electricity to be delivered by 2030, which, when it was signed in 2020, was the largest renewable energy sales contract globally.

To contribute to meeting this goal, Sweden and Swedish companies can leverage the long history and reputation of automation, and its leading position in the industrial 4.0 wave, providing smart solutions for areas including manufacturing, tooling, engineering processing, quality tests, packaging, and transportation. The effort and innovation of these solutions and the high impact on sustainability is both valued and in demand in the semiconductor industry.

Swedish companies can enter, benefit, and contribute to Taiwan's semiconductor industries by becoming partners and/or suppliers in the areas of new

12 KEY STRATEGIES FOR TAIWAN'S PATHWAY TO NET-ZERO EMISSION IN 2050

1. *Wind solar PV*
2. *Hydrogen*
3. *Innovative energy*
4. *Power systems energy Storage*
5. *Energy saving*
6. *CCUS: Carbon capture, utilisation, and storage*
7. *Carbon-free electric vehicles*
8. *Resource recycling and zero waste*
9. *Carbon sinks*
10. *Green lifestyle*
11. *Green finance*
12. *Just transition*

materials, renewable energy supply, green transition methodology, and smart production. Semiconductor clusters in Taiwan are densely populated in the west part of the island, within 250 km of the two largest cities, Taipei and Kaohsiung. The mega foundries are naturally attractive targets, but the whole supply networks need to be part of the clusters to achieve the goal of a sustainable, smart future.

2. NEW MATERIALS AND TECHNOLOGIES

The development of Artificial Intelligence (AI), including the emergence of technology like ChatGPT, relies heavily on high performance Computing (HPC); powering HPC would not be possible without advanced chips. The merging of AI with the Internet of Things (IoT) is also a clear stream, and to relate the object and its information, 5G and 6G are in the spotlight. The automotive market is also a critical industry which will increasingly demand semiconductor technology, The recent partnership announcement between NVIDIA and MediaTek at COMPUTEX Taipei 2023 in May will see a surge in demand, particularly as the market value is set to reach USD 12 billion as they accelerate the industry through the green and digital transition.

"[Artificial intelligence] presents a huge opportunity for the semiconductor industry, as the marvellous breakthroughs of AI applications have been possible based on three factors."

Dr Mark Liu
Chairman, TSMC
At CEO Summit, SEMICON TAIWAN 2023

To be able to reach the ambitious technology and sustainability leaps, every stop along the value chain needs to grow and develop, and here is a great potential for Swedish companies to find opportunities. We see that in these application areas, Swedish companies have well-known strengths, both traditionally and innovatively. These applications need to be supported with more advanced and integrated designs, in which the new materials, in particular the wide bandgap semiconductors, and innovations of engineering will be so much needed. Combining these contributions will create novel value for the semiconductor industry and benefit the development exponentially.

"NVIDIA is a world-renowned pioneer and industry leader in AI and computing. With this partnership, our collaborative vision is to provide a global one-stop shop for the automotive industry, designing the next generation of intelligent, always-connected vehicles, through this special collaboration with NVIDIA, we will together be able to offer a truly unique platform for the compute intensive, software-defined vehicle of the future."

Dr Rick Tsai
CEO, MediaTek
At COMPUTEX TAIPEI 2023

While the technological leaps and trends are impressive, they cannot be achieved without the infrastructure to support their progress. Telecom solutions, 6G, and satellite internet access are

receiving attention with the view that they are needed the above applications. As the practical demands of communication speed and security increases over time, there will be a need for a new generation of solutions within the market, and Swedish companies can play an important role here too.

3. DATA PLATFORM AND CYBER SECURITY

The integration of data for processing with a high demand of security is a relatively new topic and has become a major interest for different segments across the semiconductor industry. Product information from upstream to downstream needs to be accessible, shareable, and integrable, while attention also needs to be given to data security as cyber-attacks can target valuable information. In the early days of semiconductor production, factories were often isolated to keep data secure and business processes confidential, however, as the overall size and complexity of process flow grows, companies need to come together to implement joint solutions that can work for the clusters.

The global cyber security standard for *FAB* equipment, *SEMI E187*, released in 2018, and the *Reference Practice* in 2022, covering four perspectives of operation technology and gives guidelines for cyber defence. This is also an opportunity of Swedish companies to provide solutions in terms of digitalisation with data integration and security features that cross supply chains. And again, this issue is also connected to AIoT, across hardware and software.

"AI and accelerated computing are fuelling the transformation of the entire auto industry, The combination of MediaTek's industry leading SoC and NVIDIA's GPU and AI software technologies will enable new user experiences, enhanced safety and new connected services for all vehicle segments, from luxury to mainstream."

Jensen Huang,
Founder and CEO, NVIDIA
At COMPUTEX TAIPEI 2023

ASPECTS OF SEMI E187 CYBER SECURITY STANDARDS

1. *Operating system support*
2. *Network security*
3. *Endpoint protection*
4. *Security monitoring*

TAKE ACTION TO GROW MARKET PRESENCE

Taiwan's growing semiconductor ecosystem and its influence on the world stage is undeniable; for Swedish companies, the question is not if they should consider Taiwan, but when and how they can establish in the market.

While the market is vibrant and open, there is still a need to prepare and understand the nuances and challenges for market entry and establishment. Our key recommendations for Swedish companies are to:

- Conduct a market analysis to understand your position and relevance in the semiconductor ecosystem
- Prepare to engage with partners and customers to streamline and facilitate rapid access to the market; a supportive and competent local partner will rapidly help unlock market potential
- Embrace a quick and agile approach; the semiconductor clusters in Taiwan are dynamic, a cultural feature which contributes to the unique and successful ecosystem
- Follow and do your homework on the latest *Semicon Taiwan* updates. *Semicon Taiwan* is the largest professional semiconductor event in Taiwan, which can provide you with important insights and guidance

BUSINESS SWEDEN – YOUR LOCAL PARTNER

Business Sweden works with both Swedish companies and international companies to accelerate innovative technologies and solutions in semiconductor materials, equipment, and scale-up production methods, while also promoting sustainability across value chains.

Our global perspective, coupled with local knowledge and teams on the ground in over 40 markets means we can:

- Connect companies and other stakeholders in international markets to support business, investment, and R&D collaboration opportunities.
- Identify new segments and sales potential in export markets which offer scalable options for sustainable investments in Swedish semiconductor value chain.
- Support Swedish companies to expand in globally with solutions and innovations that can accelerate sustainable semiconductor development and production.

Our team in Taiwan has the global and local market knowledge to support Swedish companies to explore and identify opportunities across the value chain, ultimately providing industry with proven smart solutions that can help the semiconductor ecosystem in Taiwan meet global demand.

We tailor our support to help companies map and execute their strategic expansion plans. We also bring together Swedish companies and local stakeholders from across industry to collaborate through the *Green Transition Alliance*.

We help Swedish companies grow global sales and international companies invest and expand in Sweden.

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