WRITTEN EVIDENCE FROM THE DEPARTMENT FOR DIGITAL, CULTURE, MEDIA AND SPORT TO THE BUSINESS, ENERGY AND INDUSTRIAL STRATEGY SELECT COMMITTEE'S INQUIRY, "THE SEMICONDUCTOR INDUSTRY IN THE UK"

Introduction

1. Semiconductors are an essential component of electronic devices - there are multiple in our phones - and they underpin products such as cloud servers, industrial automation, critical infrastructure and defence systems, as well as fridges, radios and thermostats. Revenue from semiconductors alone accounted for 0.5% of Global GDP in 2020, but this understates their importance given the cross-section of sectors that depend on them.

2. In response to recent events such as the chip shortage, geopolitical tension and high-profile investment security cases, governments have accelerated strategies and increased investment plans in the sector.

3. The UK possesses a number of strengths within the sector, including design, compound semiconductors and academic research. In design, the UK has the second largest number of design houses globally. The UK has compound semiconductor capabilities across the supply chain, with world-leading research, development, innovation and commercialisation in the technology. Finally, this is underpinned by the UK's world leading research capabilities - with less than 1% of the world's population, the UK accounts for 7% of the world's academic publications, and 14% of the world's most highly-cited academic publications.

4. Over the last 18 months, on behalf of the government, DCMS has been reviewing its approach to the semiconductor sector and designing a strategy around three main objectives, which have been developed in consultation with sector experts:

    a. **Ensuring the UK has a reliable supply of semiconductors** - The recent shortage has highlighted the fragility of the supply chain and the range of dependencies in other sectors.

    b. **Ensuring an assured supply of semiconductors for the UK** - As a key underpinning technology, semiconductors hold an important geopolitical position in the tech ecosystem, as well as presenting cybersecurity issues for both sensitive and broad-based applications.

    c. **Protecting and growing UK capability, and seizing opportunities** - Whilst the UK does not have cutting edge silicon manufacturing capabilities, we do have key strengths in semiconductor design, compound semiconductors, and in academic research in related fields.

5. DCMS intends to publish a UK Semiconductor Strategy setting out its approach to the global and domestic semiconductor sector in autumn.

Q1: What is the current and future anticipated demand for common products built with semiconductor materials (e.g. computer chips) both within the UK and globally?

6. Currently, the semiconductor sector is experiencing consistently high demand. Last year the industry experienced a 26.6% increase in sales, reaching a record $556bn. The vast majority of semiconductor demand is driven by consumer products, such as computers and laptops (31.5%) and phones (30.7%).

7. Over the next decade, demand for semiconductors is predicted to rise significantly, predominantly driven by the automotive industry, data storage and wireless technologies. Specific estimates vary, but analysts are estimating a real term annual growth rate for demand in the sector at around 7% between 2021 and 2031.[1] However, analysts believe that despite large investments to increase supply, global chip demand is likely to outstrip capacity over the next 10 years.[2]

8. While the demand increase is a long-term trend, it does mask variation within the market. The semiconductor industry has historically had a cyclical demand and supply cycle, with some analysts predicting that the current supply shortage will turn into a glut in some semiconductors by the end of the year.

9. There are also distinct demand trends for different types of semiconductors. For example, memory semiconductors, which store information, have a much shorter life cycle than other types of chips, and historically have been more exposed to dips in demand. Logic chips, used for more complex processing tasks, require more customisation and have a longer life cycle, which has left these chips less exposed to dips in demand. In 2019, global semiconductor sales declined by 12% but this number was largely driven by a 30% revenue decline in memory semiconductors whereas the rest of the industry saw much more moderate declines.

Q2 and Q4: Q2 What is the UK's semiconductor supply chain and is this secure? If not, how can this be improved? What specific strengths does the UK have to contribute to regional or global semiconductor supply chains? How competitive is the UK within the global context of the semiconductor industry?; Q4 In which industries does the UK not have an end-to-end semiconductor supply chain? Are there any opportunities for these supply chain gaps to be filled within the UK?

10. The UK and global economy is dependent on a predictable and sufficient supply of semiconductors across a wide range of applications. Semiconductors are consumed by the economy in a number of ways, either as individual components for manufacturing or in finished products. The majority arrive in the UK as part of an integrated end-use application, for example installed in cars, phones and fridges. These products underpin everything from MRI machines and ventilators in the health system, to telecom relays and data-centres in communication networks.

[1] https://www.mckinsey.com/industries/semiconductors/our-insights/the-semiconductor-decade-a-trillion-dollar-industry

[2] https://www.nytimes.com/2022/01/25/business/economy/chips-semiconductors-shortage.html

11. In addition, a large variety of semiconductors are required for these products and systems, with different node sizes (the scale of the components, down to 3nm) and functionalities (logic, graphics, memory, analogue). For example in one type of modern car there are approximately 3800 different semiconductors. A ventilator uses a different semiconductor to determine the rate, volume and amount of oxygen per breath, to accurately adjust oxygen levels and control the speed of the monitor that determines the mechanised breathing for a patient. Each semiconductor used in these products will come from different factories, each with their own unique and complex supply chain.

12. The global semiconductor supply chain is highly complex and globalised. Broadly, there are three main segments in the production of a semiconductor: design, manufacturing and advanced test and packaging. However, these three broad categories can be broken down into around 2000 individual steps into the supply chain. Due to the high capital and technical requirements required, especially for manufacturing and design, the industry has evolved so that each step is largely carried out separately, with a small number of companies specialising in different segments. Due to this specialisation, a typical semiconductor supply chain will involve multiple companies in multiple countries and no country has an end-to-end semiconductor supply chain for any industry, and it is not likely that any country could build this capability.

13. Although semiconductor supply chains do bring efficiencies, they are also highly vulnerable to disruption, mostly due to market concentration. Taiwan produces 92% of cutting edge (sub 10nm) chips, and close to 70% total market share in manufacturing by revenue, underpinning the functioning of almost all sectors globally. South Korea is the leading global supplier of all memory chips. China and Taiwan collectively account for 65% of the final packaging stage of semiconductor production. Companies in the Netherlands and Japan hold near monopolies on specific chemicals and equipment used in semiconductor manufacturing. Two US companies, Synopsys and Cadence, hold an 80% share of the market for electronic design automation software used in designing chips. UK-based company ARM is dominant in mobile computing technology, with 95% of the world's smartphones based on ARM IP.

14. In addition, there are significant financial and technical barriers to entering the semiconductor market. The technical complexity of placing greater computing power in smaller packages is expensive, both in manufacturing infrastructure and R&D, resulting in cutting edge commercial-scale chip plants costing upwards of £10 billion. Demand for some key semiconductor manufacturing equipment is greater than supply, representing another bottleneck in growing chip supplies. Semiconductor manufacturing and R&D both require skilled staff who command high wages and are in demand globally.

15. The semiconductor sector is currently in a period of disruption, caused by a number of factors in the early stages of the pandemic. Due to long-lead times and fully allocated capacity the disruption is predicted to last until 2023. The pandemic created additional demand in the consumer electronics sector whilst automotive companies

cancelled orders for chips, after predicting a dip in demand for cars which did not materialise. A series of unexpected supply side shocks in the US and Japan also contributed. The disruption has impacted many sectors, but KPMG analysis suggests that the automotive sector has been particularly badly hit, accounting for 80%[3] of the $125bn estimated lost sales as a result of the shortage, despite only accounting for 10% of global semiconductor sales.

16. The UK possesses a number of strengths within the supply chain, including design, compound semiconductors and academic research:

    a. Semiconductor design **-** The UK is a world-leader in semiconductor design. We have the second largest number of design houses globally, and is home to companies such as ARM, whose processors were used in 25 billion devices in 2020 alone, and Graphcore, a UK semiconductor unicorn which has designed a cutting edge processor specifically for AI compute.

    b. Compound semiconductors and new material solutions **-** Compound semiconductors combine two or more elements to create a semiconductor. The UK has compound semiconductor capabilities across the supply chain, with world-leading research, development, innovation and commercialisation in the technology. We have centres of excellence, including the National Epitaxy Facility, Cambridge Centre for Gallium Nitride, and the world's first compound semiconductor cluster. Market demand for compound semiconductors is expected to grow significantly over the next 10 years, with annual growth rates varying from 7 - 26% out to 2030.[4] The UK also has disruptive material solutions companies like PragmatIC, who have recently secured $80 million to build their second fab in the UK, where they manufacture thin-film printed ICs which can be produced ten times faster and more cheaply than conventional silicon.

    c. Academic research **-** Underpinning our strengths in compound and design are the UK's world leading research capabilities - the UK ranks 4th for producing influential semiconductor research publications.[5] Our universities provide talent and innovative spin-out companies, such as Salience Labs - an AI chips company, from Oxford University, which recently closed a seed funding round of $11.5 million.

17. The UK has very limited silicon manufacturing capabilities. Out of approximately 23 semiconductor manufacturing facilities, around 12 of these have capabilities to produce silicon semiconductors (with the rest manufacturing compound semiconductors). The UK's silicon manufacturers either produce smaller quantities of legacy chips older than 180nm, or small quantities of niche, specialist chips often used for prototyping.

Q3: Are there opportunities for strengthening different parts of the current UK semiconductor industry? What are the potential weaknesses and strengths of the UK semiconductor industry to meet future requirements of electronic device manufacturing?

---

[3] https://assets.kpmg/content/dam/kpmg/pl/pdf/2021/10/pl-Raport-KPMG-pt-Surviving-the-silicon-storm.pdf

[4] Projections differ due to the diversity of the sector: https://www.gartner.com/en/documents/3981766; https://www.marketsandmarkets.com/Market-Reports/compound-semiconductor-market-178858112.html.

[5] Using the Field Citation Ratio (FCR). Singapore is 1st, Australia 2nd and the Netherlands 3rd.

18. Following close consultation with sector experts, industry and academia, DCMS is designing a strategy around three core objectives to strengthen the UK's approach to the sector:

    a. Ensuring the UK has a reliable supply of semiconductors - The recent shortage has highlighted the fragility of the supply chain and the range of dependencies in other sectors.

    b. Ensuring a trusted supply of semiconductors for the UK - As a key underpinning technology, semiconductors hold an important geopolitical position in the tech ecosystem, as well as presenting cybersecurity issues for both sensitive and broad-based applications.

    c. Protecting and growing UK capability, and seizing opportunities - Whilst the UK does not have cutting edge silicon manufacturing capabilities, we do have key strengths in semiconductor design, compound semiconductors, and in academic research in related fields.

Q5 and Q6: Q5 How can the Government strengthen semiconductor research and innovation? Are there any current areas of weakness in the present Government strategy to semiconductor innovation? Is there effective communication between various stakeholders within the UK's semiconductor ecosystem?; Q6 Does the UK have the required skills, talent and diversity to be able to boost its current semiconductor industry and respond to future disruption?

19. Through our extensive engagement with industry, we are aware of a number of issues in the UK sector, such as skills, access to finance, capital costs and sector coherence. Many in the industry believe that there is a critical shortage of talent - and diversity - in the sector, with both a lack of quantity of engineers and a lack of specialist education being consistently provided. Start-ups face difficulties such as high costs for IP, tools and licences which increases the need for high upfront capital which in turn limits their ability to attract investment. We have also heard that the sector lacks coherent representation, with no single body representing the whole sector, unlike in other countries.

20. On behalf of the government, DCMS has been developing the forthcoming Semiconductor Strategy which will set out how HMG intends to support this vital and strategically important sector. It will set out the government's vision for all three of our strategic objectives; ensuring a reliable supply of semiconductors, ensuring an assured supply of semiconductors and growing the UK's domestic sector. For the domestic sector, it will explore how to increase communications, research, innovation, coordination and, in conjunction with the Digital Strategy, support the development of a strong talent pipeline.

Q7: What are the potential national security concerns or vulnerabilities in our semiconductor industry? How should the UK collaborate with the United States or the European Union? What are the ramifications on other industries and the wider economy within the UK?

21. DCMS is considering four primary types of risks and vulnerabilities arising from the global semiconductor sector:

    a. Supply chain risk - The recent supply chain disruption has exposed how market concentration has made the semiconductor sector highly vulnerable to both natural and geostrategic disruption. This is particularly acute in the manufacturing of silicon semiconductors in Taiwan, Due to the complex, global nature of the supply chain international cooperation will be vital to address shared challenges in the sector.

    b. Defence and security risk: In addition, a supply of general and specialist semiconductors are required for defence and security capabilities as they underpin everything from weapons system to communications and infrastructure. Furthermore, our defence and security systems need assured semiconductors, which have not been exposed to cybersecurity risks. A disruption to the supply of semiconductors therefore could erode the UK's defence and security capabilities. The Ministry of Defence and UK Intelligence Services have long been working to assure their semiconductor supply chains and to ensure sufficient resilience to disruption.

    c. Economic security risk - Due to their importance for national security and defence purposes, some actors may attempt to use economic engagement to acquire UK semiconductor technologies which can present national security risks to the UK. To robustly manage these risks, the UK has a number of tools at its disposal, including export controls which the government strengthened through the enhanced military-end user controls introduced in May 2022 and the new National Security and Investment Act which commenced on 4 January 2022.

    d. Cybersecurity risks - We are concerned about cybersecurity vulnerabilities that are designed into hardware. To address this, the government has developed the Digital Security by Design (DSbD) programme - led by UKRI and BEIS - which is collaborating with industry to help prevent the exploitation of up to 70% of existing vulnerabilities. However, we are also concerned about the introduction of new vulnerabilities too, regardless of whether they are intentional or inadvertent. This could undermine confidence in connected systems; for example, vulnerabilities exploited in connected cars will reduce uptake across the UK and could cause damage to the transport system nationally.

Q8: Is the Government currently providing the clarity and direction required to enable growth and security in the semiconductor industry? Are the right governmental organisations involved with ensuring effective development of our current semiconductor industry to thrive in the future?

22. On behalf of the government, in autumn DCMS will publish the forthcoming Semiconductor Strategy which will set out how HMG intends to support this vital and

strategically important sector. The strategy has been developed in close collaboration with other government departments.

June 2022