September 2024

Department for Science Innovation & Technology: Semiconductor Sector Study

Final Report

Perspective Economics

Contents

I. Executive Summary

This report presents findings from research undertaken to produce a baseline of semiconductor-related economic activity in the UK. Commissioned by the Department for Science, Innovation and Technology (DSIT) in 2023, the study is intended to enable a better understanding of future progress towards the objectives and commitments set out in the National Semiconductor Strategy (NSS)[i].

1.1. Headline Sector Metrics

- Dedicated semiconductor companies generated £9.6bn in revenues in 2022. This represents approximately 2% of global semiconductor revenues, of which more than 40% (£4.1bn) was generated by UK headquartered companies.
- Arm is the largest UK headquartered semiconductor company, accounting for 25% of the revenue and 20% of employment, among the subset of 210 dedicated semiconductor companies included in this report.
- Among dedicated semiconductor companies, revenue per employee ranges from £225k among micro-sized enterprises to £750k among large enterprises.
- Average GVA per employee among dedicated semiconductor companies is estimated to be approximately £460k (305k if Arm is excluded).
- Dedicated companies employ an estimated 15,000 people in the UK. UK headquartered companies account for more than 60% of this total (n=9,313).
- According to data produced by this study, on average, every one person employed in a technical semiconductor role supports between three and four additional employees in non-technical roles within the same company.
- Applying broader Semiconductor Industry Association (SIA) multipliers suggests that employment in the UK semiconductor sector could support up to a further 86,000 jobs in the wider economy.
- Dedicated semiconductor companies have secured a total of £1.7bn in grants and fundraisings to date.
- Approximately 70% of total fundraisings having been secured by just five companies. Further, approximately 75% of total fundraisings have been secured by growth-stage (more mature) semiconductor companies.

1.2. Key Findings

- The UK is an attractive global location for semiconductor research and design activity, evidenced by the fact that 72% of the dedicated, internationally headquartered semiconductor companies identified through this study undertake research, development, design and IP activity in the UK.
- The UK has a niche and highly specialised semiconductor sector that is highly relevant to numerous strategically significant UK companies.

- Currently, dedicated UK headquartered semiconductor companies are more likely to be involved in the telecommunications and compute sectors, whereas more internationally headquartered companies are involved in the UK's automotive, aerospace and defence sectors.
- Support for deeper engagement between UK headquartered semiconductor companies and strategically significant OEMs in the UK's automotive, aerospace and defence sectors could further support UK-led development of new and emerging semiconductor technologies.
- More generally there is a need to coalesce the strategically significant diversified companies identified within this study around UK strengths in emerging semiconductor materials and technologies. Relatedly, several strategic stakeholders pointed to a requirement for more holistic, end-to-end approaches to semiconductor sector support.
- Among the subset of dedicated, UK headquartered SMEs identified through the study, both semiconductor design / IP activity and manufacturing have been important sources of employment growth over the past 5 years, as has activity focussed on compound and emerging materials.
- 90% of survey respondents expect to see either rapid or moderate growth in their semiconductor activity over the next two years.
- Increasing access to fundraising for companies at earlier stages of development (seed and venture stages) may go some way to addressing perceived scale-up challenges identified in survey findings.
- Future revenue scenarios suggest that dedicated UK semiconductor revenues could be between £13bn and £17bn by 2030. The difference in semiconductor revenues over the six years to 2030 under the low and constant (high) growth scenarios is estimated to be £13.5bn.
- Qualitative research with both strategic stakeholders and industry representatives returned very strong sentiment that tangible and decisive policy action is now urgently required to support sustainability and future growth of semiconductor activity in the UK.

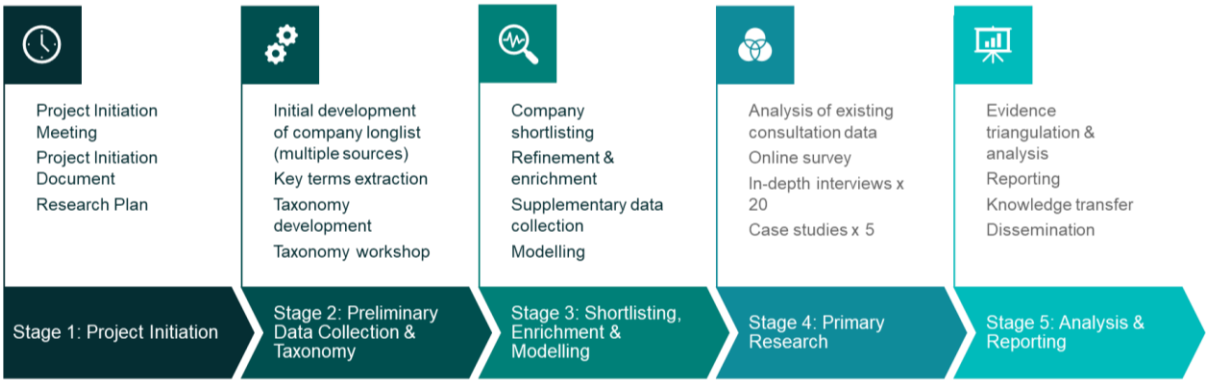
1. Introduction

To assess progress towards the objectives and commitments set out in the National Semiconductor Strategy (NSS), the Department for Science, Innovation and Technology (DSIT) required an extension of the evidence base that it currently holds regarding the economic activity of companies involved in UK semiconductor supply chains. DSIT therefore commissioned Perspective Economics (PE), Glass.ai (Glass) and a consortium of advisors led by the Institute for Manufacturing (IfM) to conduct a study into the UK semiconductor sector. The research presented in this report seeks to provide further detail regarding semiconductor sectoral activity in the UK.

1.1. Methodology & Approach

The study follows an approach that is consistent with, and builds upon, those used to produce similar evidence regarding the UK's cyber security and artificial intelligence (AI) sectors. The approach is summarised in Figure 1.1 below and described in detail in the report appendices.

Figure 1.1 – Overview of Approach & Methodology



Following the project initiation phase, the study team undertook a broad search for relevant companies spanning web data, proprietary data platforms, other desk-based sources, and companies already known to DSIT through research including but not limited to the recent semiconductor infrastructure study[ii].

The web-based search for in-scope businesses used glass.ai proprietary technology which reads data from the web on an ongoing basis. Machine learning driven techniques were applied to search within the web data to identify "candidate" entities, including:

- Keyword matches (defined through taxonomy development involving sector experts and available in the report appendices), taking into account the strength of keywords in the defined taxonomy and frequency of occurrence across web data sources.
- Both bespoke and generalised language models trained on web data from a stratified sample of entities known to be in-scope for the study.

- Classification of activity descriptions and sectoral information provided by the business on social networking/business websites.
- Review and iteration, where good instances of relevant companies are identified within the web data (technologies employed, certifications required, commonplace member organisations/icons) these are regularly identified and integrated into the approach in an iterative manner.

The web-based search returned a total of 777 candidate entities. These were combined with other data inputs to produce a final longlist of companies considered to be potentially within the scope of the study. Additional datasets included:

- IfM infrastructure study list (166 companies)
- Gateway to Research (90 companies)
- FAME key terms search (149 companies)
- Beauhurst (40 companies)
- DSIT dataset (247 companies)

The longlist of companies was used to gather additional data from proprietary and web-based sources. A combination of automated and manual review resulted in the removal of 153 companies, leaving a set of 623 companies for inclusion in the analysis. Automated review involved testing the relevance of descriptive information about each company using a large language model. Each company description was assigned a semiconductor relevance score of between 0 and 10. Subsequent manual review involved i) further desk-based research regarding any entity assigned a relevance weighting of 4 or less and ii) further desk-based research regarding any entity for which technical semiconductor employment was not identified.

Of these 623 companies 69% (n=432) were identified as relevant via more than a single input source. Of the 210 dedicated companies referenced in subsequent analyses, 80% (n=168) were identified via more than a single input source.

A final list of in-scope semiconductor companies was reviewed by sector experts and agreed with DSIT. The final company dataset was enriched using web data (Glass.ai) and proprietary data sources including Bureau van Dijk and Beauhurst.

Qualitative data was gathered via 21 in-depth stakeholder interviews and an online survey of 66 semiconductor businesses. Estimates of sector revenue, employment and GVA were developed using a combination of company data and business survey findings.

1.2. Acknowledgements

The study team would like to extend its sincere thanks to its panel of expert advisors from the Institute for Manufacturing (IfM), the Compound Semiconductor Applications Catapult (CSAC), TechWorks (TW) and Dr Rob Hardeman, and to all those who gave their time to contribute to the research.

2. Sector Profile

The study combined desk research and workshop findings to agree a definition of the semiconductor sector, and two lower-level taxonomies (supply-chain taxonomy and functional taxonomy) to facilitate more granular analysis. This section summarises the outcome of collective definitional and taxonomy development work including a taxonomy workshop involving sector experts both within and external to DSIT, and subsequent iteration of the functional taxonomy between the core study team and its panel of expert advisors.

2.1. Defining the UK Semiconductor Sector

According to the US Semiconductor Industry Association (SIA) definition, semiconductors are 'highly specialized components that provide the essential functionality for electronic devices to process, store and transmit data'. Most of today's semiconductors are integrated circuits, also referred to as "chips" composed of active discrete devices (transistors, diodes), passive devices (capacitors, resistors, inductors, MEMS) and the interconnections between them, layered on a thin wafer of semiconductor material, typically silicon'.

This study seeks to identify the size and scale of semiconductor design, development and manufacturing activity within the UK. As such, the study is concerned with both UK owned and headquartered companies, as well as with internationally owned semiconductor companies that have activity in the UK. The report refers to 'UK semiconductor companies' throughout, which includes both UK and internationally headquartered companies. In some cases distinctions are made between UK headquartered and internationally headquartered companies. Where this occurs, the analysis refers specifically to each of these two cohorts.

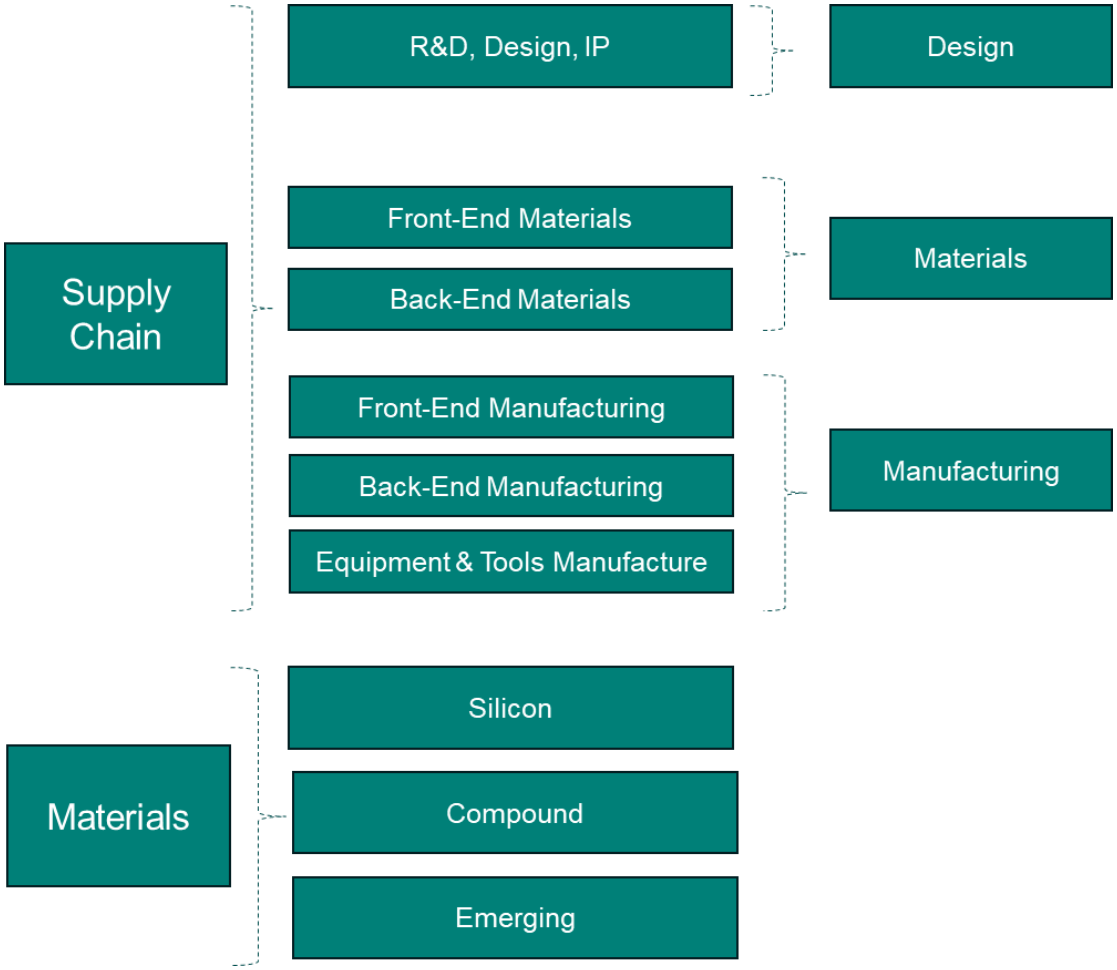
Table 2.1 below explains how semiconductor companies are defined for the purposes of the study, including with respect to the primary focus of company activity, the geographic footprint of in-scope companies and the size of in-scope companies.

Table 2.1 – Study Definition of Semiconductor Activity

Parameter		Definition
Company Activity	Dedicated	Companies that specialise in the design, development, and manufacture of semiconductors. Including companies across the semiconductor supply chain spanning design, materials and manufacturing that have at least one technical employee in the UK. To avoid inflating estimates of productive UK activity the definition of 'dedicated' semiconductor companies excludes large companies that do not undertake any design or manufacturing activity in the UK.
	Diversified	Companies operating across a wide range of industries and sectors, of which the semiconductor industry is one. In-scope companies must have descriptive evidence of active engagement in semiconductor-related activity e.g., supply of products or services to the semiconductor industry, ongoing semiconductor related research or development / integration of chips as part of a broader product or service offering. These companies may have technical semiconductor employees but technical employment is not a pre-requisite for inclusion.
Geographic Footprint	UK Headquartered	Companies with registered headquarters in the UK and may also have international operations.
	Foreign Headquartered	Companies with registered headquarters outside of the UK but with UK operations.
Size	SME	Consistent with the Companies Act 2006, the term SME is defined to include: • Micro companies (1 – 9 employees) • Small companies (10 – 49 employees) • Medium sized companies (50 – 249 employees)
	Large	Consistent with the Companies Act 2006 large companies are defined as having staff headcount of more than 250 employees.

Figure 2.1 overleaf illustrates the segmentations most commonly used throughout the report. Detailed supply chain and functional taxonomies are provided in the report appendices.

Figure 2.1 – Common Sector Segmentations

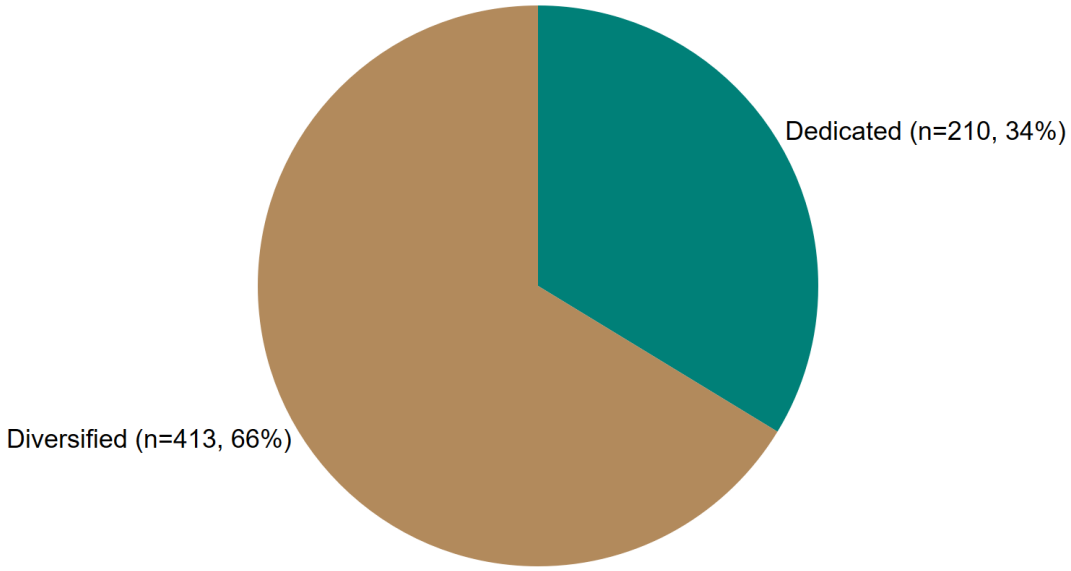


Source: Semiconductor Taxonomy Development Workshop

2.2. Number of UK Semiconductor Companies

The study has identified a total of 623 companies involved in the UK semiconductor sector. This includes 210 'dedicated' semiconductor companies and 413 diversified companies[iii].

Figure 2.2 – Dedicated and Diversified Semiconductor Companies



Source: Various (Glass.ai, Bureau van Dijk, Beauhurst, IfM)

Within the dedicated cohort of companies 66% are headquartered in the UK and 34% are headquartered internationally (n=138 and 72 respectively).

2.2.1. Registered Companies by Size

92% of all companies identified are micro, small or medium sized (SME) companies. Dedicated semiconductor companies are smaller than diversified companies on average, with 95% of dedicated companies classified as SMEs, compared to 91% of diversified companies. The 11 companies classified as large in the dedicated segment (5% of 210) account for 63% of the revenue and 53% of employment.

There are more medium-sized companies among the dedicated cohort (22% of dedicated companies are medium-sized (n=47), compared to 18% of diversified companies). These medium-sized semiconductor companies employ approximately 5,000 people and have 110 employees on average.

Figure 2.3 – UK Semiconductor Company Size

Size	Dedicated	Diversified
Large	5% (n=11)	9% (n=38)
Medium	22% (n=47)	18% (n=73)
Small	31% (n=65)	34% (n=140)
Micro	41% (n=87)	39% (n=162)
Grand Total	100% (n=210)	100% (n=413)

Source: Bureau van Dijk, Glass.ai *(note: totals may not sum due to rounding)*

Dedicated, UK headquartered companies are typically smaller than their international counterparts. 79% of UK headquartered companies are either micro or small, compared to 55% of internationally headquartered dedicated companies.

2.2.2. Semiconductor Company Registrations

There has been a relatively constant rate of new dedicated company incorporations since the late 90's and early 00's. Between 2016 and 2023 there have been an average of 8 new company incorporations each year[iv].

Most recently (between 2020 and 2023) there have been seventeen new UK headquartered company incorporations[v]. More than three quarters of these companies are involved in R&D, design and IP activity (n=14) and account for a majority of associated employment and revenue. Example companies include but are not limited to:

- Literal Labs – one of the first group of 12 UK semiconductor start-ups supported by Silicon Catalyst's ChipStart accelerator programme. Mignon designs hardware built to run large-scale artificial intelligence models using more efficient chips.
- Falkata Semi – an analogue and layout design company specialising in providing IP cores, custom chip design services, verification and validation, prototyping and broader turnkey solutions for the semiconductor industry.
- Vector Photonics – specialising in developing advanced semiconductor laser solutions, Vector Photonics focusses on innovating and commercialising a new class of Photonic Crystal Surface-Emitting Lasers (PCSELs).

2.2.3. Semiconductors activity by supply chain segment

The study team applied tailored large language model (LLM) scripts to descriptive company information to categorise semiconductor companies according to the supply chain taxonomy set out in Figure 2.1. Categorisations were manually reviewed and updated where relevant based on expert sectoral knowledge. Each dedicated semiconductor company was assigned a 'best-fit' supply chain category. While this approach offers a degree of clarity within the analysis, it is recognised that in many cases companies undertake activity across more than one segment of the supply-chain. Table 2.1 provides some illustrations of these overlaps.

Table 2.1 – Design & Manufacturing Activity Overlaps (Illustrative)

Company	Description	Supply Chain Best Fit
Texas Instruments	Texas Instruments (TI) is a leading global semiconductor company that has been driving progress through innovation for decades. Specializing in the design, manufacture, testing, and sale of analog and embedded processing chips.	Design: Globally Texas Instruments operates across multiple segments of the semiconductor supply chain its UK activity is predominantly R&D related.
SPTS (KLA)	SPTS Technologies, a KLA company, is a global leader in designing, manufacturing, selling, and supporting advanced etch, deposition, and thermal processing equipment and technologies for the semiconductor and microdevice industries.	Manufacturing: Globally SPTS is involved in the design and manufacture of semiconductor equipment and tools. The company undertakes both R&D and manufacturing activity in the UK. The company has significant manufacturing activity at its Newport site.
Dynex Semiconductor	Dynex Semiconductor Ltd specializes in designing, manufacturing, and supplying high and low power semiconductor devices and modules, including power diodes, thyristors, IGBT modules, and integrated power assemblies.	Manufacturing: Dynex undertakes both R&D and manufacturing activity in the UK. The company has significant manufacturing activity at its Lincoln site.
IQE	Specializing in the development, manufacture, and supply of compound semiconductor wafers, IQE leverages advanced epitaxy technology to produce bespoke 'epi-wafers' tailored to specific electronic or optical properties required by major chip manufacturers.	Manufacturing: IQE is a leading global supplier of advanced semiconductor wafer products and services with several manufacturing sites across the UK.
ST Microelectronics	STMicroelectronics is a leading global semiconductor company that designs, manufactures, and markets a wide array of microelectronics products, focusing on delivering intelligent and energy-efficient solutions.	Design: ST Microelectronics is a multinational company headquartered in Switzerland. It has manufacturing sites across Europe and Asia and a strong R&D presence in the UK.

Source: Glass.ai / Perspective Economics

Acknowledging the 'best-fit' caveat, the supply chain analysis suggests that:

- 67% of dedicated semiconductor companies active in the UK are primarily involved in research and development, design and IP related activities (n=140). Example companies include Arm, Imagination Technologies, XMOS.
- 28% are involved primarily in semiconductor manufacturing activity, including both front and back-end manufacturing and the manufacture of semiconductor equipment and tools. Example companies include SPTS, IQE, Plessey, Semefab, Clas-SIC Wafer Fab (n=59).
- 5% are primarily involved in the supply of materials to front or back-end manufacturing. Example companies include Porotech, Entegris, Applied Materials (n=11).

The supply chain profile of dedicated, UK headquartered companies is not significantly different to these overall proportions. 64% of UK headquartered companies are involved in research, development, design and IP activities and 30% are involved in manufacturing.

72% of internationally headquartered dedicated companies are involved in research, development, design and IP – emphasising the UK's significance as a location for research and design related semiconductor activity.

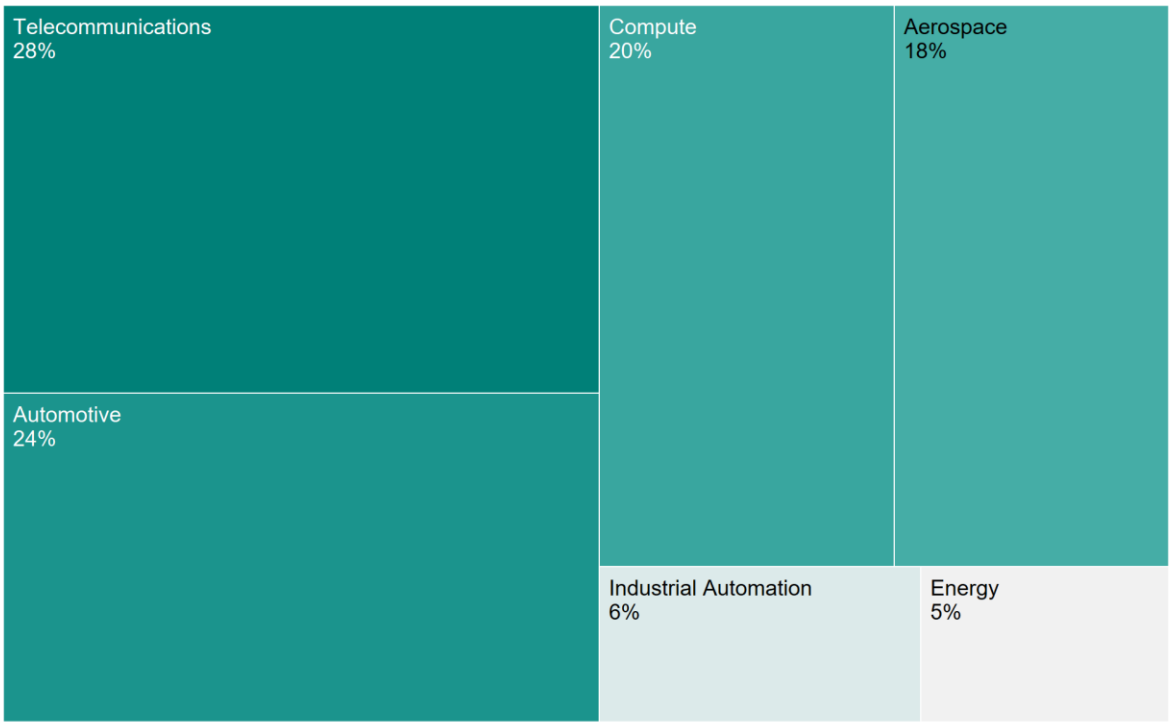
It is also worth noting here that the UK has a substantive cohort of companies involved in the manufacture of equipment and tools used by the semiconductor sector. Within this study, these companies are included across both the dedicated and diversified categories because in many cases they supply a range of sectors including but not limited to the semiconductor sector. Example companies included within the 'diversified' category include:

- Infinitesima – a privately owned company originally spun out from Bristol University's Scanning Probe Microscopy Group. Infinitesima has developed a revolutionary atomic force detection system used by both semiconductor equipment companies and integrated circuit manufacturers more generally.
- Edwards Vacuum – developers of state-of-the-art vacuum pump and abatement service solutions across the semiconductor sector and the broader research and development landscape.

2.2.4. Semiconductors activity by application area

Applying a similar ‘best-fit’ application approach to the set of dedicated semiconductor companies suggests that a majority are involved in or work with the telecommunications, automotive, compute and aerospace sectors (Figure 2.4).

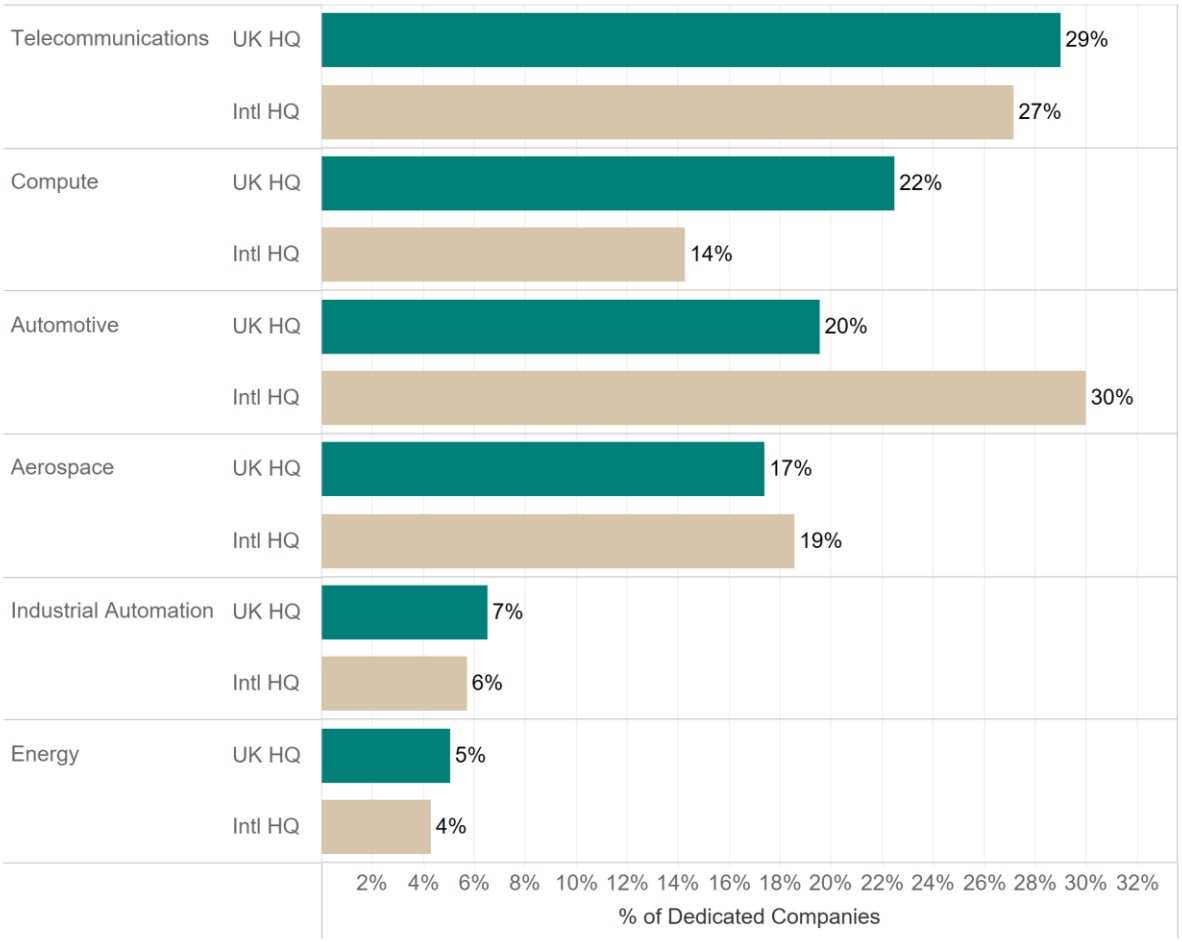
Figure 2.4 – Dedicated Companies by Sector



Source: Glass.ai *(note: totals may not sum due to rounding)*

Based on the analysis, telecommunications and compute are key application areas for dedicated UK headquartered semiconductor companies. 51% of dedicated UK headquartered companies are involved in or work with the telecommunications and computing sectors, compared to 41% of internationally headquartered dedicated companies (n=71 and 30 respectively). Just under one third of international companies are involved in the automotive sector (30%, n=22), compared to one fifth of UK headquartered companies (20%, n=27).

Figure 2.5 – Dedicated Companies by Sector (UK HQ | Intl. HQ)



Source: Glass.ai *(note: totals may not sum due to rounding)*

2.2.5. Regional Semiconductor Supply Chain Activity

Approximately half of all dedicated semiconductor companies (including both internationally and UK headquartered companies) are located outside of London, the South East and the East of England.

Arm accounts for a significant proportion of both total revenue, and total employment among dedicated, UK headquartered semiconductor companies (54% and 32% of total revenue and employment respectively). With its headquarters in Cambridge, Arm makes the East of England a focal point of semiconductor sector activity in the UK.

To better understand the geographic composition of semiconductor activity among other companies, the study looked specifically at a subset of dedicated UK headquartered companies excluding Arm[vi]. This subsequent analysis emphasises the significance of regions outside London and the South East to the UK's semiconductor sector (Table 2.2). For example, within this subset, Wales is home to less than 10% of dedicated, UK headquartered companies, but accounts for 14% of employment and 30% of revenues.

Scotland accounts for almost one quarter of revenues and the South West accounts for almost one fifth of employment.

Table 2.2 – Significance of Regions to Indigenous UK Semiconductor Activity*

Location	% Firms	% Employment	% Revenue
East of England	20%	26%	18%
Wales	8%	14%	30%
Scotland	11%	11%	24%
South East	21%	10%	7%
South West	11%	18%	8%
London	11%	10%	8%

* Data excludes Arm, which makes up 54% of revenue and 32% of employment, adding to the geographic significance of the East of England.

Source: Bureau van Dijk, Glass.ai, Perspective Economics

2.3. Location of Dedicated Semiconductor Companies

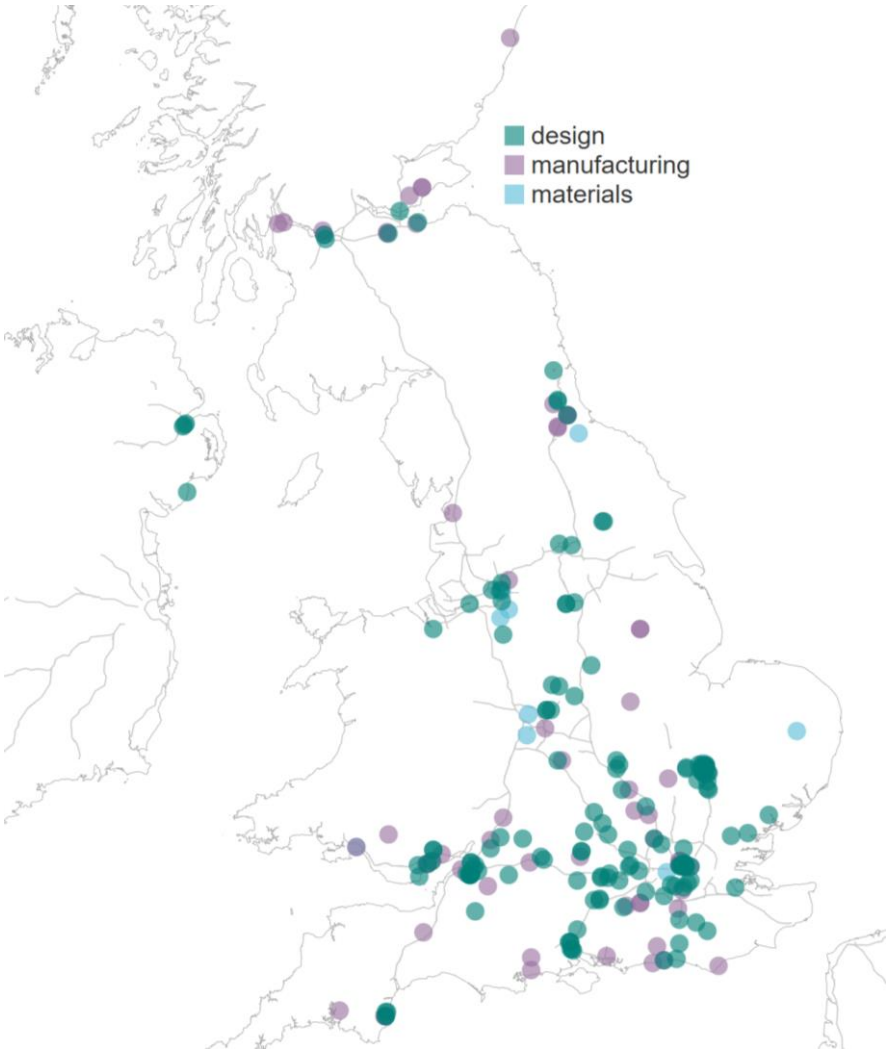
Location data for 1,634 UK semiconductor sites was obtained by Glass.ai, including registered and trading addresses.

2.3.1. UK Trading Locations

Analysis of UK location data shows known clusters of semiconductor companies in Bristol, Cambridge, the North East of England, Northern Ireland, Scotland and South Wales. It also shows clusters in the North West, the Midlands and along the south coast of England.

Main manufacturing clusters are in Scotland, Wales and the North East. There are design clusters in and around London, particularly in Cambridge, and along arterial routes between London and Bristol, Oxford and Southampton.

Figure 2.6 – Dedicated UK Semiconductor Company Locations – UK HQ Only



Source: Glass.ai, Perspective Economics

3. Economic Contribution

3.1. Estimated Revenue

In 2022 global semiconductor sales totalled $574bn[vii]. In the same year, dedicated UK semiconductor companies generated estimated revenues of approximately £9.6bn (around 2% of the global figure[viii]).

3.1.1. Revenue by Company Size

Globally in 2022, almost two thirds of semiconductor revenues were generated by 10 companies. UK company revenues are similarly concentrated: 25% of revenues raised by UK dedicated companies included in this report are accounted for by a single company (Arm) (rising to 54% among UK headquartered dedicated companies). The top 10 UK headquartered companies account for 88% of revenues.

62% of dedicated company revenues are generated by large companies. Medium-sized companies account for just under one third of dedicated revenues, adding weight to the significance of this segment to the UK's semiconductor industry.

Table 3.1 – Dedicated Semiconductor Revenue by Size

Size	Revenue (£, Rounded)	% of Total Revenue
Large	£6,000,000,000	63%
Medium	£3,100,000,000	32%
Small	£400,000,000	4%
Micro	£100,000,000	1%

Source: Bureau van Dijk, Perspective Economics (2022 data)

Diversified companies include several major strategically significant UK headquartered companies involved in collaborative semiconductor research and development activity, such as BAE Systems, Jaguar Land Rover, Rolls-Royce and Dyson.

Average revenue per employee among dedicated UK semiconductors companies is estimated to be approximately £635k. Revenue per employee ranges from £225k among micro companies to £750k among large companies.

Table 3.2 – Revenue by Supply Chain and Headquarters Location

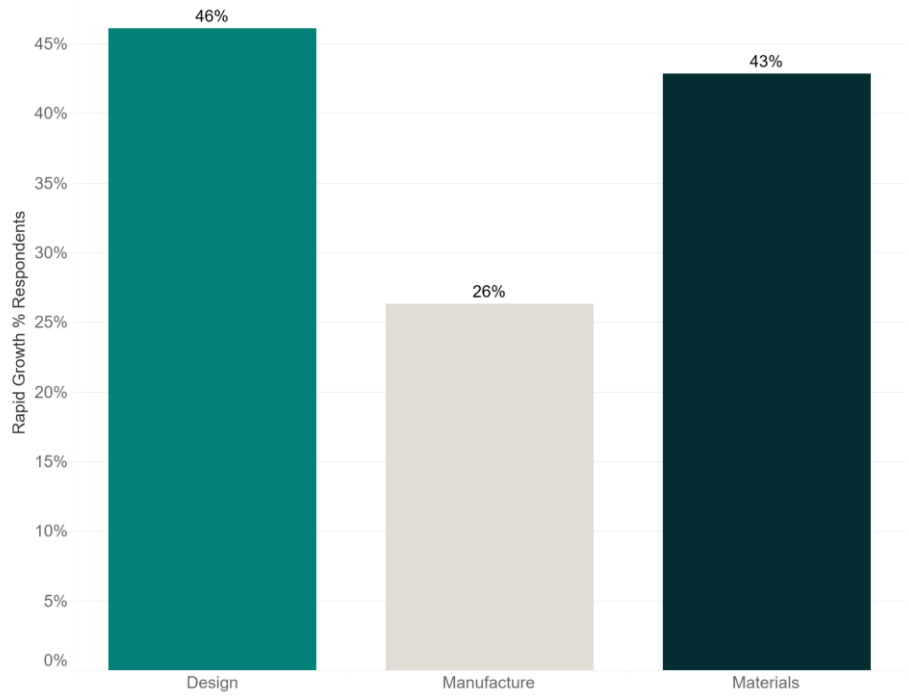
Supply Chain Segment	Intl HQ	UK HQ	Total	Percentage
Design	£5,186,000,000	£2,982,000,000	£8,168,000,000	85%
Materials & Manufacturing	£306,000,000	£1,164,000,000	£1,470,000,000	15%
Total	£5,492,000,000	£4,146,000,000	£9,638,000,000	100%

Source: Bureau van Dijk, Perspective Economics (2022 data, figures may not sum due to rounding)

3.1.2. Future Growth Drivers

90% of survey respondents expect to see either rapid or moderate growth in their semiconductor activity over the next two years. However, sentiment regarding the pace of growth varied according to the primary focus of business activities. Notably higher proportions of respondents involved in design and materials related activity expected to see rapid growth in future (Figure 3.2).

Figure 3.2 – 'Rapid Growth' Sentiment by Activity



Source: Perspective Economics

Expectations of 'rapid growth' were similar among companies working across the breadth of semiconductor material types, including silicon, compound materials or emerging materials. In all cases, around 30% of respondents were anticipating rapid growth.

Power electronics was among the most prominent drivers of future growth referenced. Design, IP and specific materials (GaN on silicon) were also identified as future growth drivers.

When asked to highlight significant barriers to business growth in the next two years, funding and investment, scale-up support and experience of scaling semiconductor companies were among the most commonly cited factors.

3.2. Estimated Employment

In the latest year for which complete data is available dedicated UK semiconductor companies employed an estimated 15,000 people in the UK. UK headquartered companies account for more than 60% of this total (n=9,313).

Survey data suggests that on average for every one person employed in a technical semiconductor role, a further four people are employed in non-technical support roles (e.g., sales, HR etc.). Data on the number of people in technical roles within dedicated companies suggests a similar ratio, at three non-technical employees for every one technical employee. Therefore, according to data produced by this study, every one person employed in a technical semiconductor role supports between three and four additional employees in non-technical roles.

The Semiconductor Industry Association (SIA) estimates that for every US worker directly employed by the semiconductor industry, a further 6.7 jobs are supported within the wider US economy. Acknowledging differences in the size, scale and profile between the semiconductor sectors in the US and the UK, assuming a similar multiplier suggests that the sector in the UK could support up to a further 86,000 jobs in the wider economy.

3.2.1. Employment by Company Size

Among dedicated companies, around 53% of total employment is within large companies and just over one third of employment is within medium sized companies. Table 3.2 provides a summary of employment numbers and percentages within dedicated semiconductor companies of different sizes, according to whether they are headquartered in the UK or internationally.

Table 3.2 – Employment by Size and Headquarters Location

Size	International HQ		UK HQ	
Large	2,057	35%	5,977	64%
Medium	3,105	53%	2,064	22%
Small	452	8%	1,020	11%
Micro	234	4%	252	3%

Source: Bureau van Dijk, Glass.ai (2022 data[ix])

R&D, design and IP companies account for approximately two thirds of employment among dedicated, UK headquartered companies. The skew towards design is partially driven by the

presence of Arm, which employs around a fifth of the UK semiconductor workforce. Manufacturing accounts for just over one third of employment among dedicated, UK headquartered companies. Removing Arm from the analysis results in the share of employment between design and manufacturing among dedicated UK headquartered companies being broadly equal (50% / 49%), highlighting the significance of indigenous UK semiconductor manufacturing in the wider sector.

3.2.2. Technical Employment in Dedicated and Diversified Companies

Analysis of technical employment within dedicated and diversified semiconductor companies suggests that 33% of those employed in dedicated companies work in technical roles. 18% of those employed in diversified companies work in technical roles[x].

3.3. Estimated Gross Value Added

In 2022, dedicated UK semiconductor companies created an estimated £7.4bn in GVA[xi], driven predominantly by R&D, Design and IP companies in the East of England. Again, Arm is a key contributor to GVA, accounting for almost half of the total (£3.4bn).

Average GVA per employee among dedicated UK semiconductors companies is estimated to be £460k when Arm is included. GVA per employee remains high at £305k per employee across all dedicated companies excluding Arm.

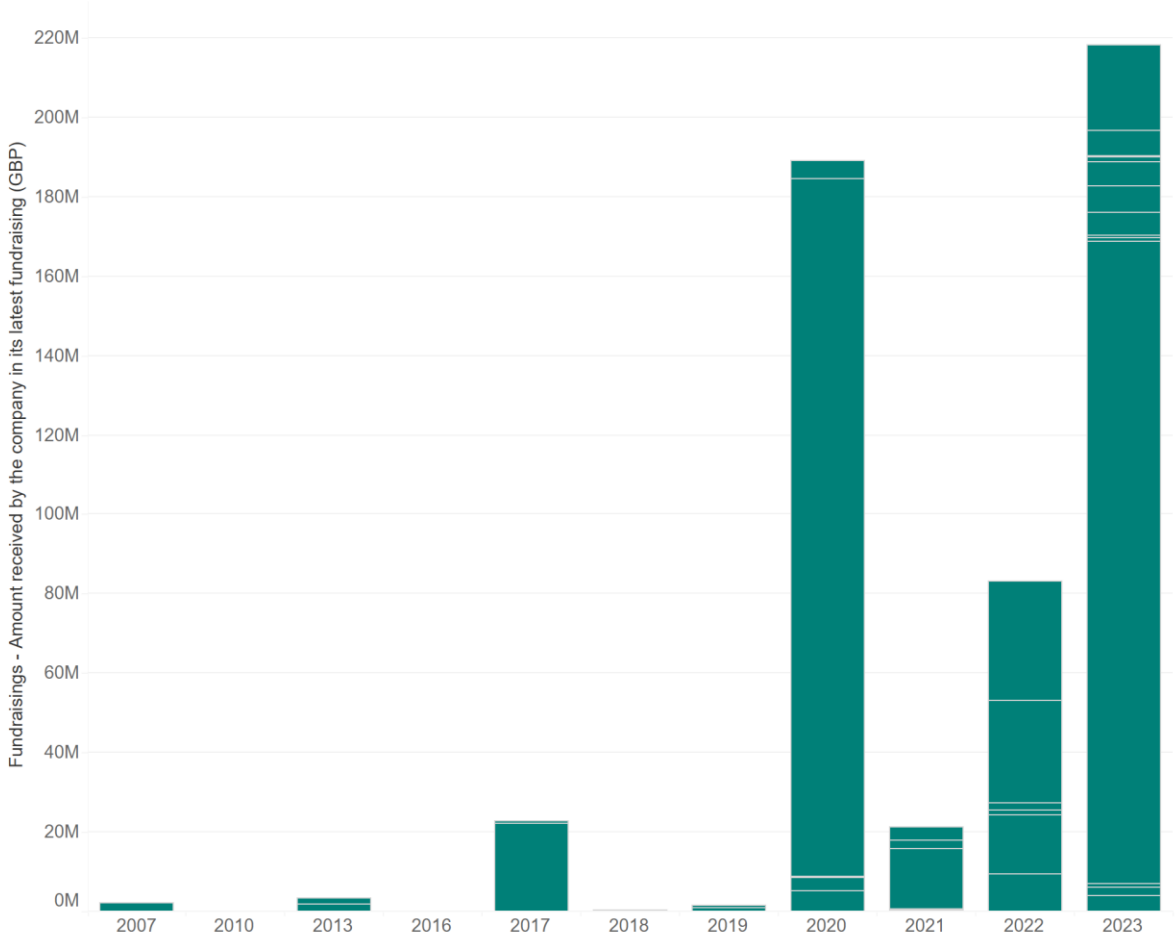
4. Investment

4.1. Investment to Date

Dedicated UK semiconductor companies have secured a total of £1.7bn in grants and fundraisings[xii]. This includes £291m in grants and £1.4bn in fundraisings. Forty-four companies have secured fundraisings, with approximately 70% of total fundraisings having been secured by five companies.

Figure 4.1 shows the value of fundraisings secured by dedicated semiconductor companies within their latest fundraising rounds. N.B. previous fundraising values are not shown and totals therefore do not sum to the total £1.4bn.

Figure 4.1 – Latest Fundraisings



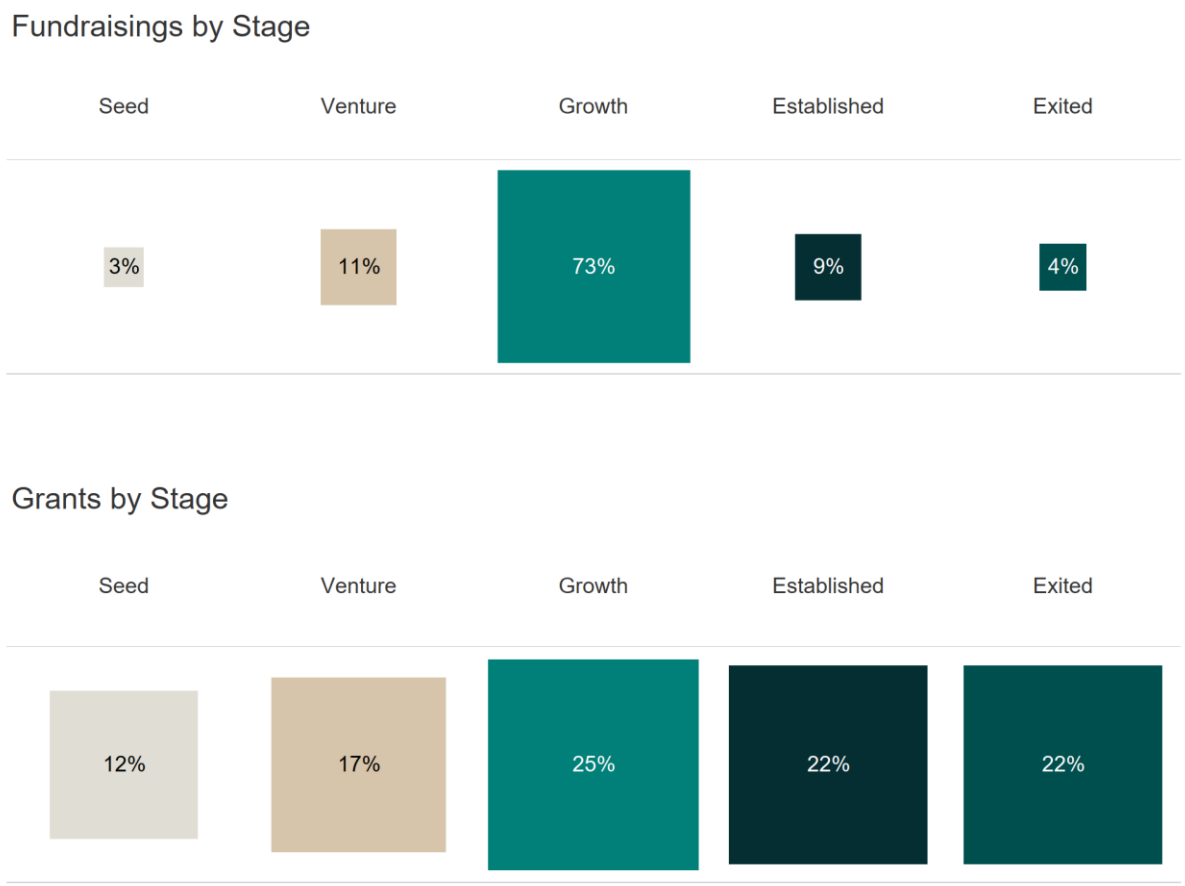
Source: Beauhurst (all latest fundraisings, 2007 - 2023)

4.1.1. Investment by Stage of Evolution

Just under three quarters of total *fundraisings* have been secured by growth-stage semiconductor companies. The value of *grants* secured by dedicated companies is more evenly spread across stages of evolution, including notably higher proportions secured by

seed and venture-stage companies. Increasing access to fundraising for companies at seed and venture stages may go some way to addressing perceived scale-up challenges discussed in response to survey findings in Section 5.

Figure 4.2 – Fundraising by Stage of Evolution



Source: Beauhurst (all grants and fundraisings, 2000 - 2023)

4.1.2. Investment by Location

Companies with registered offices in London account for 35% of total grants and fundraisings secured by dedicated semiconductor firms. The North East, South West, East of England and Wales make up the rest of the top 5 grants and investment raising regions, each accounting for between 10% and 20% of total grants and fundraisings by dedicated companies.

4.2. Investment Market Dynamics

4.2.1. Investors & Funding Sources

Molton Ventures, Amadeus Capital and Cambridge Innovation Capital have been the top three investors in dedicated UK semiconductor companies by value. Technology Venture Investments (Development Bank of Wales), Cambridge Angels and Amadeus Capital Partners have been the top three investors in dedicated UK semiconductor companies by number of fundraisings.

Consultation with prominent UK investors in semiconductor companies highlighted how important it was to have confidence in a pipeline of follow-on funding, and that recent geo-political events (particularly the US Chips Act and trade restrictions) present an opportunity to 'shift' larger scale follow-on funding "from East to West".

4.2.2. Investment Drivers, Challenges & Opportunities

Survey findings presented in Section 5 suggest that access to commercial lending, private investment and scale-up support for UK semiconductor companies could be more mature. Qualitative comments provided in response to survey questions regarding growth drivers and barriers specifically linked future growth expectations to availability of investment.

"There is poor investment support for compound semiconductor processing in the UK. Funding is targeted at startups and R&D, but the investment is not present in the foundry entities in the UK to enable competitive manufacture and scale-up of [semiconductor product]*."*

Survey Respondent

Lack of technical understanding among private investors and / or lack of appetite for comparatively long investment timescales were also identified as challenges.

"VC Funding, where the VCs have [limited] *technical understanding, or appetite for the investment timescales involved."*

Survey Respondent

5. Sector Dynamism & Maturity

Survey respondents were asked to rate the maturity of the semiconductor industry in the UK. Commercial lending, inward investment and scale-up support were deemed to be less mature. Research funding, innovation / collaborative research funding and start-up support were deemed to be more mature.

Figure 5.1 – UK Semiconductor Market Maturity

Market Dynamic	Less Mature	More Mature
Commercial Lending	55%	4%
Competition between UK companies	26%	24%
Innovation / Collaborative Research Funding	35%	37%
Inward Investment	55%	8%
Private Investment (Angel / VC / PE)	41%	14%
Research Funding	44%	37%
Scale-Up Support	78%	4%
Skills Development	44%	13%
Start-Up Support	40%	34%

Source: Perspective Economics (n=54)

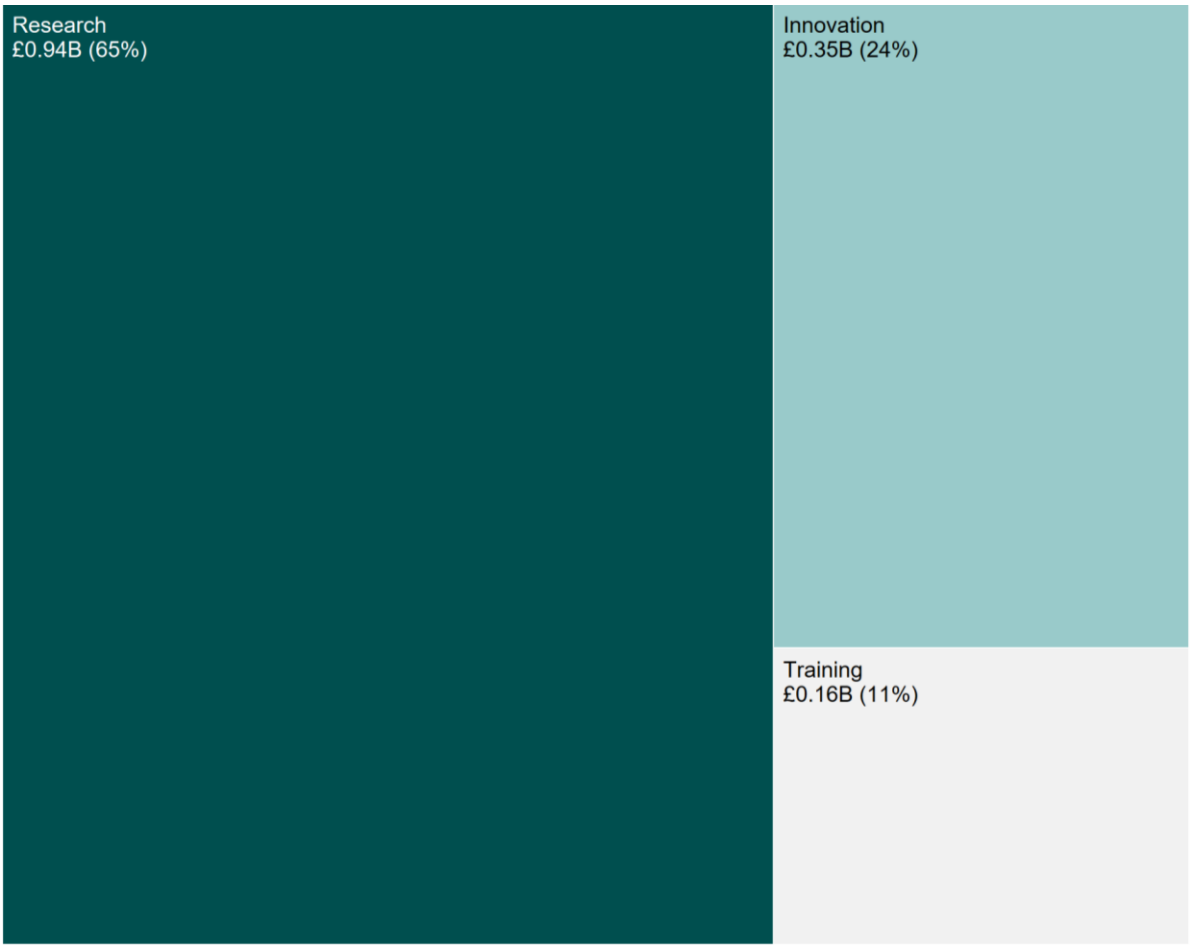
5.1. Research & Development

Survey data suggests that the UK does well when it comes to semiconductor research and innovation funding. Analysis of UKRI funding for semiconductor related research, development and innovation supports this assertion.

Since 2006 (beginning of structured UKRI funding records) semiconductor related research and innovation in the UK has received a total of £1.4bn in public investment. This funding has supported approximately 1,200 individual principal investigators (PIs). Literature suggests that the average size of research units in the UK is between 7 and 8 people[xiii,xiv] meaning that the number of researchers supported by investment in semiconductor research is likely to be considerably higher.

Figure 5.2 provides a breakdown of UKRI funding according to whether it is predominantly research or innovation oriented.

Figure 5.2 – UKRI Research & Innovation Funding



Source: UKRI Gateway to Research (start dates between 2006 – 2024)

On the basis that research grant funding is typically offered as 80% of total costs, the data suggests that total investment in UK semiconductor research alone is likely to be £1.2bn, with a further £0.5bn invested in innovation, commercialisation and training activity. (N.B. innovation funding figures are taken from UKRI Gateway to Research and do not therefore include data stored by Innovate UK outwith Gateway to Research). Therefore, since 2006, total public sector supported investment in UK semiconductor research (including contributions by UK research organisations and businesses) is likely to be closer to £2bn.

"Government supported programs for initial research [are] *well-developed. This is also fairly well developed to support start-ups in their initial formation, including innovation funding. There is a gap for transition to product and scale-up funding."*

Survey Respondent

5.2. Patents

A search for data on patents either applied for or granted between 2018 and 2023 within the US, the UK or Europe returns a total of 525,000 patent records[xv]. 81% of patent records apply to the US, 17% apply to Europe and 2% apply to the UK. Globally, TSMC, Samsung

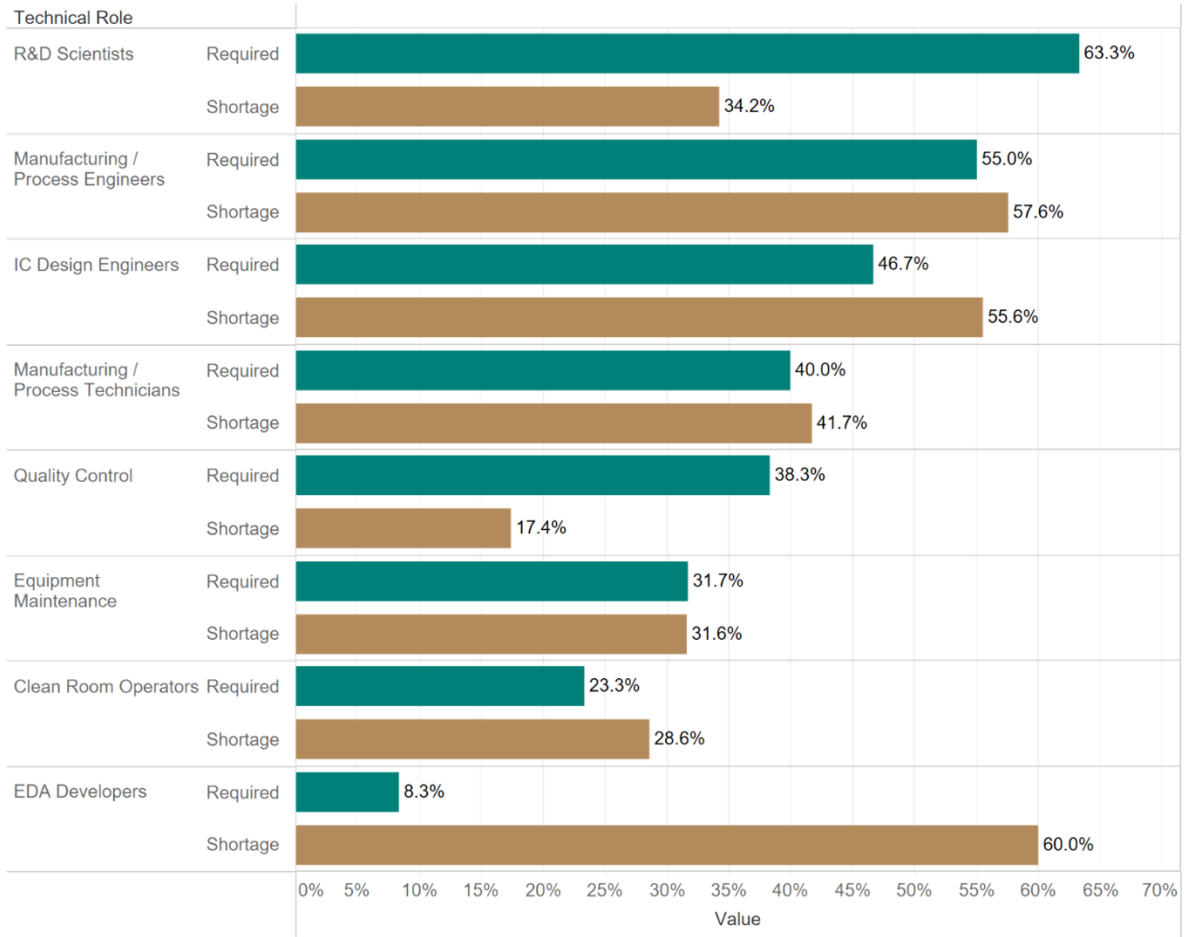
and Intel are among the most prominent applicants. Prominent UK patent applicants include Arm, Plessey Semiconductors and several companies identified as ‘diversified’ within this study including Dyson, Jaguar Land Rover and Rockley Photonics.

5.3. Semiconductor Skills Supply

5.3.1. Perceived Opportunities & Challenges

When asked to state the key technical roles required within their organisation, just under two thirds of survey respondents identified R&D Scientists, 55% identified manufacturing / process engineers, and just under 50% identified integrated circuit (IC) design engineers. When asked about availability of these key technical skills, more than 90% of all respondents suggested that there was either a moderate or acute shortage. Respondents requiring Manufacturing / Process Engineers and Technicians, and IC Design Engineers are experiencing among the most acute shortage of skills (between 50% and 60% of respondents reporting acute shortages.

Figure 5.2 – Demand & Perceived Shortage of Semiconductor Skills



Source: Perspective Economics

5.3.2. International Labour

On average, among respondent semiconductor companies 23% of new hires come from abroad. If respondents suggesting that no new hires come from abroad are removed from the analysis (i.e., considering only those companies that hire from abroad), an average of 29% of new hires come from abroad.

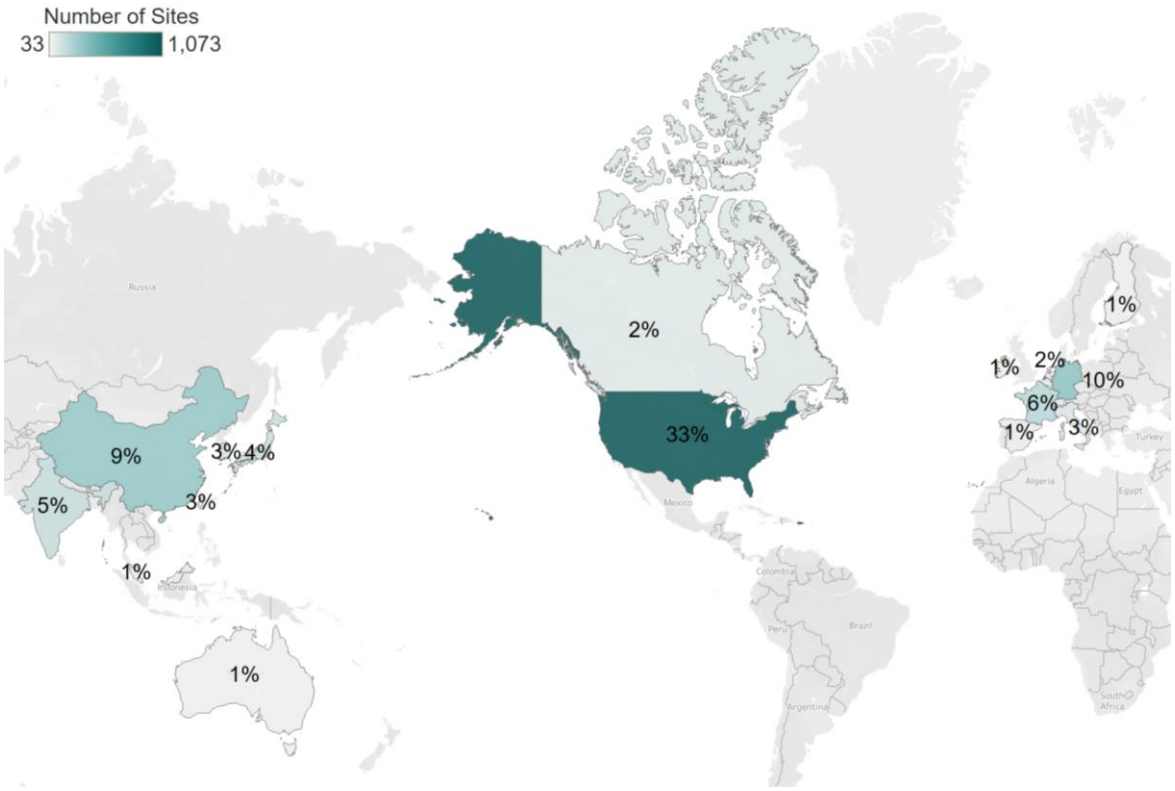
5.3.3. Emerging Skills Needs

60% of survey respondents indicated that new or emerging technical skills will be required to support future growth. Design engineers were among the most cited emerging roles, with various data oriented technical skills including artificial intelligence, machine learning, modelling and data engineers also among the most commonly referenced.

6. International Activity

Additional trading locations were gathered for 615 of the 623 companies identified through the study (including both dedicated and diversified companies). These 615 companies operate in 65 countries (other than the UK) – highlighting the global nature of the semiconductor industry. Excluding the UK, 33% of all international sites are in the US. Germany, China, France and India are also prominent locations for semiconductor companies with a UK presence.

Figure 6.1 – International Semiconductor Locations

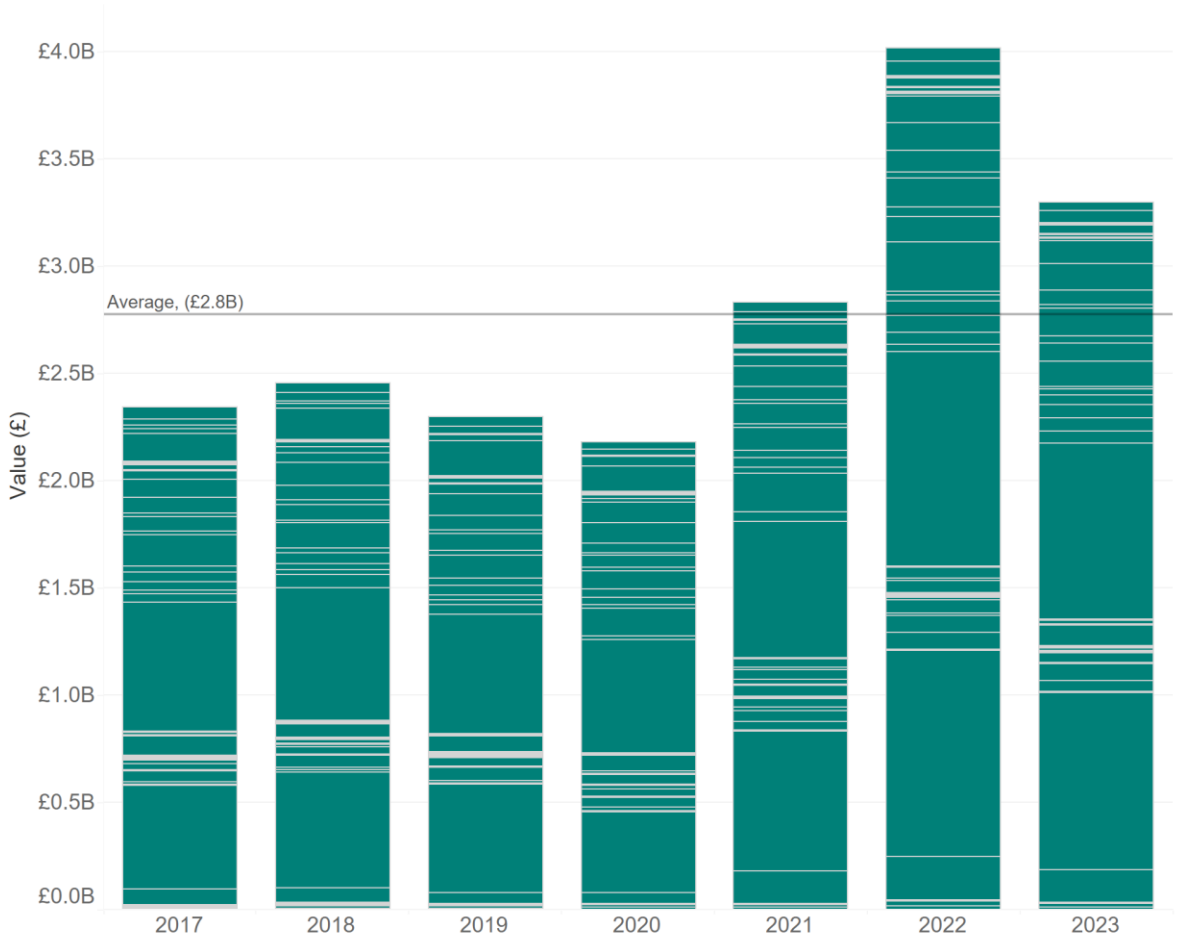


Source: Glass.ai

6.1. Semiconductor Imports

HMRC trade data shows that over the past decade UK companies have spent just £2.8bn on average each year on imports of semiconductor goods (Figure 6.2). Semiconductor import costs have seen a notable increase since 2021, driven by increases in the unit cost of various types of integrated circuits. A list of the 48 harmonised system (HS) commodity codes used in this analysis is available in the appendices.

Figure 6.2 – Semiconductor Goods Imports (£)

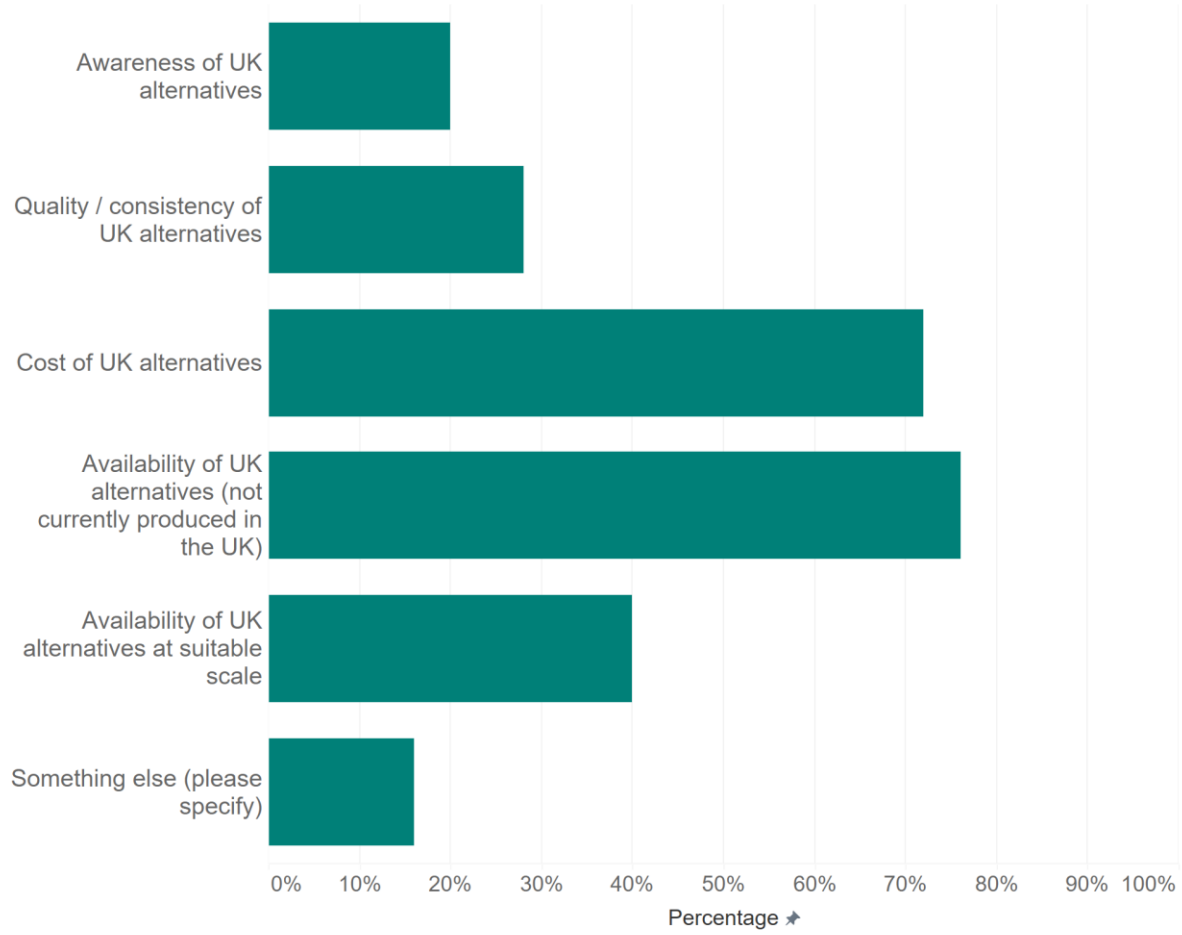


Source: HMRC UK Trade Info (2017 – 2023)

75% of survey respondents (n=45) indicated that they import products or services to enable their UK semiconductor business activity. Just over half of those respondents (56%, n=25) suggested that it is an option to increase the proportion of inputs procured from UK companies (c.40% said that this wasn't possible and 4% said that they don't know).

When asked what was preventing further diversification towards UK supply chains, cost and availability of UK alternatives were identified as the most significant barriers (Figure 6.3).

Figure 6.3 – Supply Chain Substitution Barriers



Source: Perspective Economics

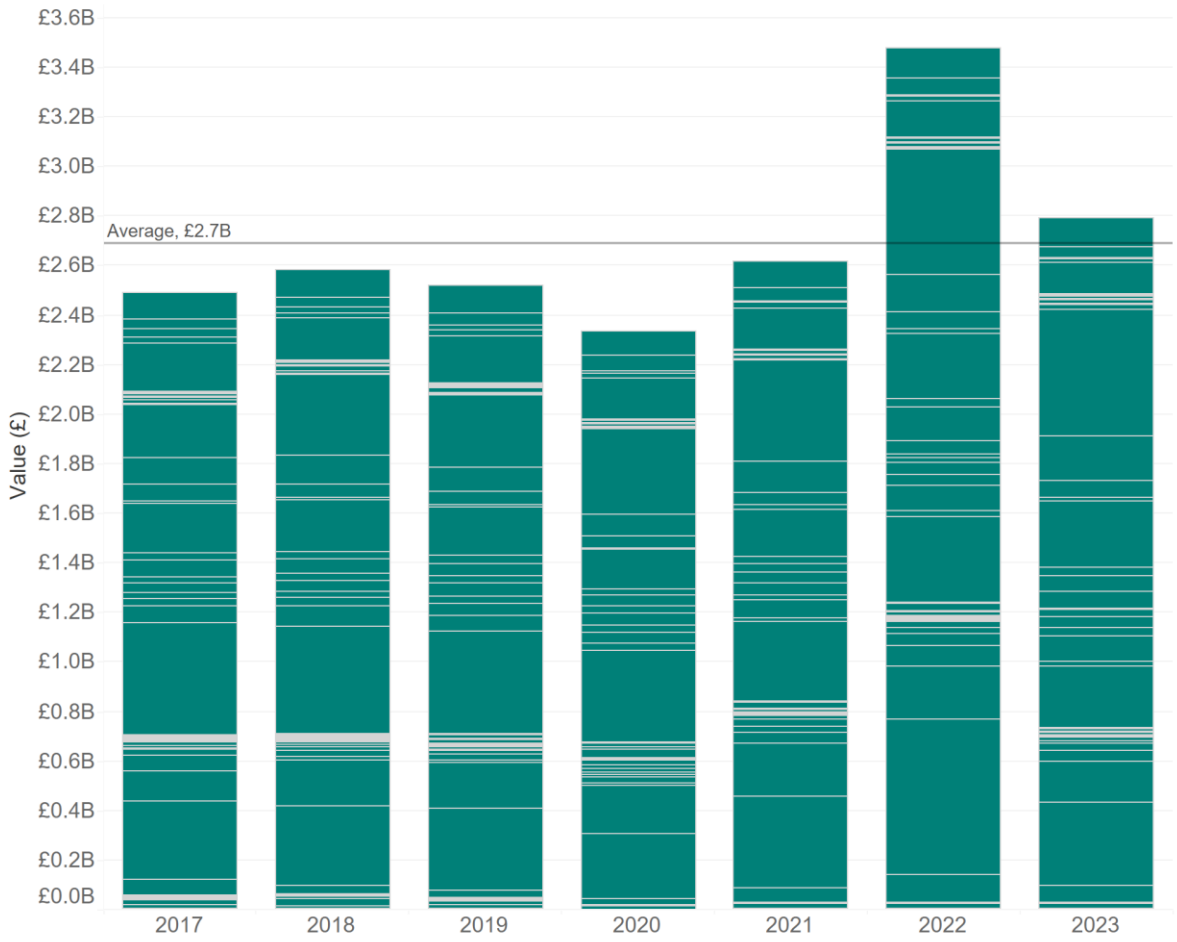
6.2. Semiconductor Exports

Based on international trading location data available to the study, 110 UK headquartered companies have 588 international sites across 47 countries. 30% of these sites are in the US, with a wider footprint spanning China, the Netherlands, India and France.

80% of survey respondents indicated that they currently export semiconductor products or services. Almost 60% of these respondents suggested that exports account for more than 75% of their total UK sales – pointing to a high degree of reliance on export markets.

HMRC trade data suggests that the value of UK semiconductor exports has seen marginal increases since 2017.

Figure 6.4 – UK Semiconductor Exports



Source: HMRC UK Trade Info (2017 – 2023)

Between 2019 and 2023, exports of machinery for semiconductor manufacturing, for semiconductor inspection and testing, and exports of transistors and diodes have been growth drivers, exhibiting average compound annual growth rates of 12%. Examples of high-growth exporting companies include Edwards Vacuum (fab support equipment), Diodes Semiconductors (ASIC products), and Analog Devices (semiconductors for battery management systems).

Data on trade and trading locations highlights the extent and breadth of UK semiconductor activity abroad. Strategic international partnerships should seek to both support UK companies abroad while also leveraging UK strengths in design and materials.

6.3. Balance of Trade

Trade data shows that the UK's balance of trade in semiconductor goods flipped from marginal positive to marginal negative between 2020 and 2021.

Figure 6.5 – Semiconductor Trade Balance

Source: UK Trade Info (2017 – 2023)

7. Future Sector Development

7.1. Sector Opportunities & Challenges

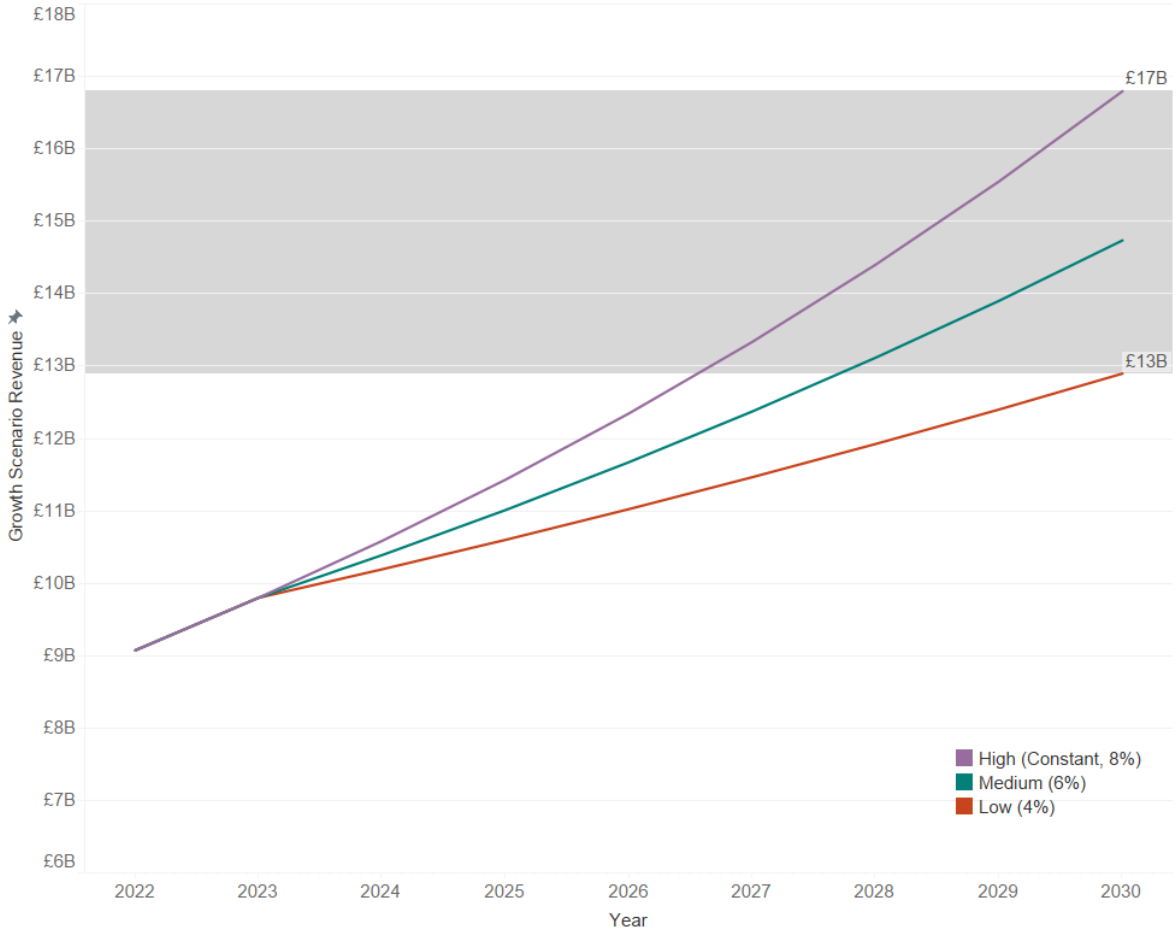
7.1.1. Future Opportunities

Historic (10-year) revenue data for 40 dedicated companies included in the study suggested an average compound annual growth rate of c.8%.

While growth rates varied substantially year on year, assuming linear year-on-year growth within low growth (4%), moderate growth (6%) and constant / high growth (8%) scenarios, dedicated UK semiconductor revenues could be between £13bn and £17bn by 2030.

The difference in semiconductor revenues over the six years to 2030 under the low and high growth scenarios is estimated to be £13.5bn.

Figure 7.1 – Future Growth Scenarios



Source: Bureau van Dijk, Perspective Economics

7.1.2. SME Employment Growth

Analysis of employment growth among dedicated, UK headquartered SMEs over the past 5 years (48 SMEs with complete data over the 2018 – 2022 period) suggests that both research, design / IP and manufacturing activity have been important drivers of employment growth.

Analysis of employment growth according to primary material type suggests that companies involved primarily in compound and emerging materials account for a majority of employment growth in recent years.

7.1.3. Key Challenges

Within the UK, semiconductor revenues and GVA are heavily skewed towards a) large companies and b) companies involved in R&D, Design and IP. As such, the sector in the UK is more sensitive to structural corporate decisions and / or global locational trends.

Qualitative research points to high demand and shortages of people in key technical roles, including but not limited to IC design engineers, R&D scientists and manufacturing / process engineers and technicians.

7.2. Potential Policy Implications

The view from the UK stakeholders consulted is that the UK should continue to build strategic international relationships that can help further lever UK strengths in R&D, Design and IP. This will require continued and globally commensurate investment in leading-edge technology and talent.

There is broad consensus among strategic stakeholders that the UK should focus on leveraging its strengths in R&D, Design and IP, and that the UK's manufacturing efforts should be directed towards establishing and scaling earlier stage emerging technologies and materials development.

Medium-sized semiconductor companies are a significant segment of the UK sector. Supporting these companies to scale will help to mitigate market concentration risks and address a perceived gap in scale up support.

Appendices

Key search terms

ADC; amplifier; DAC; mixed signal; ASIC; CMOS; CPU; DRAM; DSP; flash memory; FPGA; GPU; IPU; logic; memory; processor; ROM; discrete; photodiode; thyristor; edge emitting laser; LED; photonic; photonic integrated circuit (PIC); VCSEL; diode; GaN; IGBT; power; SiC; GaAs; InP; MMIC; MOSFET; RF; actuators; detectors; gas sensing; gas sensors; II-VI; III-V; QWHE; sensing; sensor; chip design; fabless; semiconductor design; chip manufacturer; EDA tool; electronic design automation; integrated device manufacturer; IP core; outsourced semiconductor assembly and test; chemical; coatings; gases; hydrogen; photomask; substrates; advanced material; graphene; nanomaterials; OLED; organic; perovskites; PV; chip; circuit board; electronic chip; electronic component; electronic device; electronic equipment; electronic system; electronics assembly; electronics manufacturer; integrated circuit; microchip; microelectromechanical systems; printed circuit board; semiconductor; silicon chip; silicon on insulator; silicon wafer; system on chip; antenna; artificial intelligence (AI); assembly; broadband; capacitors; communications; components; compound; consumer electronics; copper; couplers; cryptography; custom; design; design engineering; displays; EDP; electronic design; electronics; embedded; embedded design; emerging; energy; inductors; internet of things (IoT); lasers; lighting; low power; machine learning (ML); manufacturing; mechatronic; microcontrollers; microleds; microwave; modulators; power consumption; quantum; radar; radio frequency; resistors; satellite; security; silicon; soc products; software; solar panel; test; transistor; vacuum; wafers; wave; wireless.

Standard Industrial Classification Codes

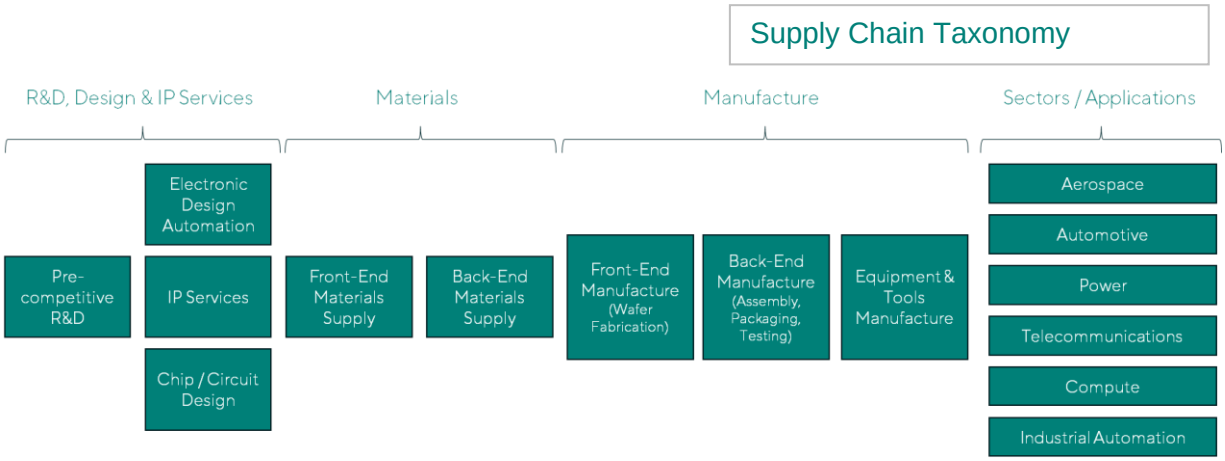
Approximately 70% of dedicated semiconductor companies are registered within 10 standard industrial classification (SIC) codes (Table 2.1).

Table A.1 – Top 10 SIC Codes (Dedicated Companies)

SIC Code	SIC Description	Percentage of Total
26110	Manufacture of electronic components	19%
72190	Other research and experimental development on natural sciences and engineering	12%
82990	Other business support service activities n.e.c.	8%
74909	Other professional; scientific and technical activities n.e.c.	7%
62090	Other information technology service activities	6%
71121	Engineering design activities for industrial process and production	5%
32990	Other manufacturing n.e.c.	3%
71122	Engineering related scientific and technical consulting activities	3%
96090	Other service activities n.e.c.	3%
27900	Manufacture of other electrical equipment	3%

Source: Bureau van Dijk

Supply Chain & Functional Semiconductor Taxonomies



Functional Taxonomy

Silicon								Compound			Emerging
Analog / Mixed Signal		Digital CMOS			Photonics	MEMS					
Integrated device	Discrete	Integrated Device	Discrete - Processors	Discrete - Memory			Power	RF (GaAs, GaN, InP)	Photonics (III-V, II-VI)	Sensors (III-V, II-VI)	
Amplifier	Diode	Field Programmable Gate Array (FPGA)	MicroProcessor Unit (MPU)	Dynamic Random-Access Memory (DRAM)	Optical Waveguide	Sensors (gas, chemical, bio)	Metal–Oxide–Semiconductor Field-Effect Transistor (MOSFET)	Monolithic Microwave Integrated Circuit (MMIC)	LED	Magnetic (QWHE)	OLED (Organic)
Op-Amp	Metal–Oxide–Semiconductor Field-Effect Transistor (MOSFET)	Application-Specific Integrated Circuit (ASIC)	Microcontroller Unit (MCU)	Static Random-Access Memory (SRAM)	Optical Transceiver	Piezo printhead	Field-Effect Transistor (FET)	Metal–Oxide–Semiconductor Field-Effect Transistor (MOSFET)	Edge emitting lasers	Photodiode	Perovskites (PV)
Analog-to-Digital Converter (ADC)	Field-Effect Transistor (FET)	Application Specific Standard Product (ASSP)	Digital Signal Processor (DSP)	Read Only Memory (ROM)	Optical Switch	Resonator	Insulated-Gate Bipolar Transistor (IGBT)	Field-Effect Transistor (FET)	Virtical emitting lasers (VCSEL)	Single Photon Detector	Microcontroller Unit (MCU, InGaZnO)
Digital-to-Analog Converter (DAC)	Insulated-Gate Bipolar Transistor (IGBT)	ASSP (System on Chip)	Graphics Processing Unit (GPU)	Flash	Optical Modulator	Inertial sensor		PIN Diode	Laser Arrays		Sensors (Graphene)
Mixed Signal	Bipolar Junction Transistor (BJT)		Intelligence Processing Unit (IPU)		Optical Processor	Mirror array		Varactor	Single Photon Detectors		
Field Programmable Analog Arrray (FPAA)	Thyristor					Precision timing		Mixer			
RF Transceiver	Photodiode							HEMT/HBT			
RF Mixer	Power Amplifier (PA)										
Application-Specific Integrated Circuit (ASIC)											
Application Specific Standard Product (ASSP)											

Source: Semiconductor Taxonomy Development Workshop

Harmonised System Commodity Codes

HS Code	HS Code Description
39199020	Self-adhesive circular polishing pads of a kind used for the manufacture of semiconductor wafers, of plastics
39201023	Non-cellular polyethylene film of a thickness of >= 20 micrometres but <= 40 micrometres, for the production of photoresist film used in the manufacture of semiconductors or printed circuits
39231010	Boxes, cases, crates and similar articles, of plastic, specially shaped or fitted for the conveyance or packing of semiconductor wafers, masks, or reticles
59119091	Self-adhesive circular polishing pads of a kind used for the manufacture of semiconductor wafers
70200005	Quartz reactor tubes and holders designed for insertion into diffusion and oxidation furnaces for production of semiconductor materials
84141010	Vacuum pumps of a kind used solely or principally for the manufacture of semiconductors or flat panel displays
84141015	Vacuum pumps of a kind used for the manufacture of semiconductors or solely or principally used for the manufacture of flat panel displays
84431940	Printing machinery for use in the production of semiconductors
84439110	Parts and accessories of printing machinery for use in the production of semiconductors, n.e.s.
84561110	Machine tools for working any material by removal of material, operated by laser, of a kind used solely or principally for the manufacture of printed circuits, printed circuit assemblies, parts of heading 8517, or parts of automatic data processing machines
84861000	Machines and apparatus for the manufacture of boules or wafers
84862000	Machines and apparatus for the manufacture of semiconductor devices or of electronic integrated circuits
84862010	Machine tools for working any material by removal of material, operated by ultrasonic processes, for the manufacture of semiconductor devices or of electronic integrated circuits

84862090	Machines and apparatus for the manufacture of semiconductor devices or of electronic integrated circuits (excl. machine tools for working any material by removal of material operated by ultrasonic processes)
84869000	Parts and accessories for machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays, and for machines and apparatus specified in note 11 C to chapter 84, n.e.s.
84869010	Tool holders, self-opening dieheads and workholders of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays
84869020	Parts of spinners for coating photographic emulsions on liquid crystal devices "LCD" substrates, n.e.s.
84869030	Parts of deflash machines for cleaning the metal leads of semiconductor packages prior to the electroplating process, n.e.s.
84869040	Parts of apparatus for physical deposition by sputtering on liquid crystal devices "LCD" substrates, n.e.s.
84869050	Parts and accessories for apparatus for dry-etching patterns on liquid crystal devices "LCD" substrates, n.e.s.
84869060	Parts and accessories for apparatus for chemical vapour deposition on liquid crystal devices "LCD" substrates, n.e.s.
84869070	Parts and accessories for machine-tools operated by ultrasonic processes, n.e.s.
84869090	Parts and accessories for machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays, and for machines and apparatus specified in note 9 C to chapter 84, n.e.s. (excl. tool holders, self-opening dieheads, workholders, those of spinners for coating photographic emulsi
85411000	Diodes (excl. photosensitive or light emitting diodes "LED")
85412100	Transistors with a dissipation rate < 1 W (excl. photosensitive transistors)

85412900	Transistors with a dissipation rate >= 1 W (excl. photosensitive transistors)
85413000	Thyristors, diacs and triacs (excl. photosensitive semiconductor devices)
85414010	Light-emitting diodes, incl. laser diodes
85414090	Photosensitive semiconductor devices, incl. photovoltaic cells
85414100	Light emitting diodes "LED"
85414900	Photosensitive semiconductor devices (excl. photovoltaic generators and cells)
85415000	Semiconductor devices, n.e.s.
85415100	Semiconductor-based transducers (excl. photosensitive)
85415900	Semiconductor devices, n.e.s.
85416000	Mounted piezo-electric crystals
85419000	Parts of diodes, transistors and similar semiconductor devices photosensitive semiconductor devices, light emitting diodes and mounted piezoelectric crystals, n.e.s.
90111010	Stereoscopic optical microscopes fitted with equipment specifically designed for the handling and transport of semiconductor wafers or reticles
90112010	Photomicrographic optical microscopes fitted with equipment specifically designed for the handling and transport of semiconductor wafers or reticles (excl. stereoscopic microscopes)
90119010	Parts and accessories of stereoscopic optical microscopes and photomicrographic optical microscopes, fitted with equipment specifically designed for the handling and transport of semiconductor wafers or reticles, n.e.s.
90121010	Electron microscopes fitted with equipment specifically designed for the handling and transport of semiconductor wafers or reticles
90129010	Parts and accessories of electron microscopes fitted with equipment specifically designed for the handling and transport of semiconductor wafers or reticles, n.e.s.

90278013	Electronic apparatus and equipment for performing measurements of the physical properties of semiconductor materials or of LCD substrates or associated insulating or conductive layers during the semiconductor wafer production process or the LCD production process
90308200	Instruments and apparatus for measuring or checking semiconductor wafers or devices, incl. integrated circuits
90309020	Parts and accessories for instruments and apparatus for measuring or checking semiconductor wafers or devices, n.e.s.
90314100	Optical instruments and appliances for inspecting semiconductor wafers or devices or for inspecting photomasks or reticles used in manufacturing semiconductor devices
90318032	Electronic instruments, apparatus and machines for inspecting semiconductor wafers or devices or for inspecting photomasks or reticles used in manufacturing semiconductor devices
90319020	Parts and accessories for optical instruments and appliances for inspecting semiconductor wafers or devices or for inspecting photomasks or reticles used in manufacturing semiconductor devices or for measuring surface particulate contamination on semiconductor wafers, n.e.s.
90319030	Parts and accessories for electronic instruments, apparatus and machines for inspecting semiconductor wafers or devices or for inspecting photomasks or reticles used in manufacturing semiconductor devices, n.e.s.

[i] https://www.gov.uk/government/publications/national-semiconductor-strategy
[ii] https://engage.ifm.eng.cam.ac.uk/uk-semiconductor-infrastructure-initiative-2023/
[iii] Dedicated companies are those with business activity related predominantly to semiconductors. Diversified companies are those that provide products or services to the semiconductor industry as part of a broader product offer.
[iv] Note that historic figures are likely to be lower reflecting longer-term churn in company incorporations and cessations.

[v] UK HQ incorporations since 2020 account for 65% of the total 26 new company incorporations including internationally owned companies
[vi] ARM accounts for c.20% of dedicated company UK employment and almost 25% of revenues.
[vii] https://www.wsts.org/67/Historical-Billings-Report
[viii] Comparison made for illustrative purposes only, note caution due to differences in underlying data. Calculation of 2% based on conversion of $574bn to £466bn using average $:£ exchange rate in 2022 of 0.8115.
[ix] Note that UK employment estimates are derived from multiple sources including published accounts, annual reports, gender pay gap reports and web data. For the majority of records the source is published accounts, annual reports or gender pay gap reports and the reference year is 2022. Where web data was used, the reference year is either 2023 or 2024.
[x] Calculation excludes companies with fewer than 3 employees.
[xi] Known GVA among these companies totals £5.7bn and the remaining £2.1bn is estimated by applying average GVA per employee figures for firms of different sizes.
[xii] All grants and fundraisings recorded by Beauhurst since 2000
[xiii] https://www.rand.org/content/dam/rand/pubs/external_publications/EP60000/EP67130/RAND_EP67130.pdf
[xiv] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4465944/#:~:text=years%20since%20publication.-,Group%20size,range%20of%201%20to%2031.
[xv] Analysis uses CPC code H01 as a proxy for semiconductor patents in line with existing literature.