

SEMICONDUCTOR

RESEARCH & DEVELOPMENT:

The UK Academic Landscape

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Executive Summary

Semiconductors are the critical technology of our time, underpinning the technology necessary for national infrastructure and modern life to function.

They enable AI, commerce, defence, finance, food systems, future compute, medical devices, renewable energy, telecommunications, and transport.^[1] All ambitions for UK's identified key technologies will only be met using semiconductors.^[2] Semiconductors should play a major part in growing the UK economy.

Despite being dependent on semiconductors to keep the country running, the UK is currently overdependent on other countries for their manufacture and supply. Other nations are moving rapidly to secure the resilience of their own supply and keep pace with technological innovation.

The UK is late to the party, and any further delay will place the country at a potentially disastrous disadvantage. Building resilience into the UK's supply of semiconductors is a national security imperative; but also offers a huge economic opportunity.

The global semiconductor market is projected to grow twice as rapidly as world GDP and will be worth at least \$1 trillion by 2030.^[3] The UK market is currently worth £10 billion.^[4] Our semiconductor industry presence is relatively small, and without urgent government action it will be further dwarfed by our neighbours in Europe and beyond, who are onshoring manufacturing.

In March 2025, Vishay, one of the world's largest semiconductor manufacturers, announced a £250 million further investment in their state-of-the-art plant, boosting production for electric vehicles, thereby delivering more skilled jobs.^[5] In September 2024, the UK Ministry of Defence purchased a compound semiconductor facility, to bolster part of a critical supply chain, further indicating the UK Government's recognition of the "strategic importance of semiconductors as a critical technology."^[6]

The major driver of innovation in this critical technology is the research grown in UK universities. There is international recognition of the UK's university semiconductor research - in both design and fabrication. The innovative developments and commercial potential of many of the discoveries in semiconductor design and technology being achieved in UK universities represents a significant economic opportunity for the UK.

The pressing concern that this report seeks to address is: how might this semiconductor research be scaled to catalyse the growth of the UK-based semiconductor industry, and in turn generate major economic growth?

[1] Quantum computing, AI data storage, and telecommunications are in turn heavily dependent on silicon photonics, which are a key part of the semiconductor ecosystem.

[2] For example, "advanced connectivity technologies, artificial intelligence, cyber security, engineering biology and quantum." The newly established (April 2025) national AI Energy Council has a major semiconductor firm on its steering committee, in clear recognition of the hardware needs of any Artificial Intelligence that might usher in "a new era of clean electricity."

[3] Most market forecasts are increasing this \$1 trillion figure substantially, because of the recent developments in Generative AI.

[4] <https://www.gov.uk/government/news/government-backs-next-wave-of-semiconductor-start-ups-to-scale-up-growth>

[5] <https://www.gov.uk/government/news/hundreds-of-millions-of-pounds-to-turbocharge-manufacturing-sector-in-wales>

[6] Ministry of Defence Purchase of Semiconductor Facility in Newton Aycliffe: Written Statement to Houses of Parliament made on 7 October 2024, by John Healey, UK Secretary of State for Defence (Statement UIN HCWS102) <https://questions-statements.parliament.uk/written-statements/detail/2024-10-07/hcws102>

Summary of the Challenge

The UK faces several risks in the semiconductor domain:

Resilience:

The UK lacks a resilient semiconductor supply and lacks sovereign capability. With a bottleneck in the global supply chain and recent developments in trade tariffs, how do we urgently improve resilience for the UK semiconductor supply chain?

Economic:

The UK has relatively little foothold in the semiconductor market ^[7] and current infrastructure investments have not been competitive with even the least bold of our international competitors. How might the UK invest in semiconductors to grow the national economy, and protect and retain IP? How might the UK invest in developing and deploying R&D infrastructure, across Technology Readiness Levels, to support industry to grow in, or locate to, the UK?

Research:

The UK academic sector faces a funding crisis which threatens the high-quality research ecosystem as researchers work in silos and are unable to prototype innovations. How might the Government back its academic R&D with a resilient and long-term funding model, to encourage more collaborative and multidisciplinary research; and grow groups with mixed expertise, allowing them to effectively address future challenges?

Talent:

The semiconductor industry facing a significant workforce challenge: there were an average of 3,830 unfilled positions in Europe between 2021 and 2023, and this is set to increase significantly by 2030. ^[8] How might we turn the global workforce challenge into a significant national employment opportunity? How might we communicate the necessity the technology for everyday life to the wider public; growing public support for public spending, and generating interest in careers in the sector?

Environmental:

Semiconductors enable the green transition, however, their manufacture carries environmental burdens. How might the UK address sustainability challenges in the sector; and turn “green semiconductors” into a highly profitable and exportable enterprise for the UK?

[7] Initial UK-based initiatives evidence economic return. For example, in South Wales, every £1m directly supported by the CS cluster supports a further £1.05m of GVA in the wider UK economy. (2023)

<https://csconnected.com/media/trijr3n/csconnected-sipf-weru-annual-report-2023.pdf>

[8] <https://chipsacademy.eu/wp-content/uploads/2024/11/ECSA-Skills-Strategy-2024.pdf>

Summary of the Report:

This report landscapes the current capability and the future potential of UK university research in semiconductors; identifies areas of promise; and investigates place-based strengths.

With a clear methodology involving over 800 participant engagements from UK-based academics and industry experts, this has resulted in the creation of the largest evidence-base for UK Research and Development (R&D) in semiconductors; and details the national academic view on the UK semiconductor landscape.

This Report establishes that the UK university research base is the foundation on which the UK should rebuild the domestic innovation and economic potential of semiconductor technology. It identifies an immediate need for the Government to fully realise that, without access to semiconductors, there is no everyday life, and urges that this realisation unleashes strategic and sustained investment, to secure a resilient semiconductor supply chain.



Optoelectronics Research Centre, University of Southampton

Recommendations

These recommendations were co-created with an expert Advisory Group, informed by the analysis of the novel evidence base established during this project.

If implemented at quality and pace at a national level, the below recommendations would grow the UK economy and significantly boost national security and resilience; converting the UK's R&D excellence into scalable, sustainable technology, with commercial outcomes.

More details on each recommendation are provided on page 43.

- 1** Prioritise **high risk, high reward** research in: (i) **advancing semiconductor materials** (e.g. compound and 2D semiconductors); (ii) **designing and modelling novel IC architectures**; and (iii) **designing and realising hybrid and heterogeneous systems**.
- 2** Establish **semiconductor prototyping capabilities** in the UK across various levels of TRLs, based on exemplar international models such as South Korea's National NanoFab Centre; and create a **small-scale silicon manufacturing capability** focused on R&D.
- 3** Increase R&D funding specifically for **semiconductors**, establishing **collaborative communities of practice** supported by Network+ grants, with the aim of growing existing (and creating new) high quality **cluster ecosystems**.
- 4** **Materially improve the proposition for researchers** in UK academia, through remuneration and other incentives.
- 5** Grow a talent pipeline for a range of staffing in semiconductor R&D and industry in the UK, with the specific aim of establishing a **new model of doctoral training across the core semiconductor topics**; and scaling up training for **technical professionals**.
- 6** Grow and ease the commercialisation of research by introducing substantial investment and more effectively exploit support to help **accelerate commercialisation of university research**; and more effectively **attract VC investment**.
- 7** Establish a **lightweight central organisation** for semiconductors, which should (i) provide information on access to national semiconductor R&D facilities, (ii) work on a bold curriculum on semiconductor skills, (iii) generate imaginative public campaigns on semiconductors, and (iv) support inward investment opportunities.



Section 10

DETAILED RECOMMENDATIONS

These recommendations were co-created with an expert Advisory Group. They are based on the analysis of the new evidence base established during this research project.

If implemented at quality and pace at a national level, the following recommendations would grow the UK economy, and significantly boost national security and resilience.

1 Prioritisation

The UK Government should prioritise the following themes of semiconductor technology, based on strong academic R&D foundations and future potential. Investments need to promote high risk, high reward research, as well as converting existing excellence into scalable, sustainable technology with a commercial outcome:

Advancing Semiconductor Materials

Particularly compound and 2D semiconductor materials to the point of manufacture, where we can bring our excellence in materials research into developing new types of designs and models for circuit design; identify new materials for making highly energy-efficient, performance-driven, and cost-efficient electronics; and create connections between materials, devices, and systems research communities.

Designing and Modelling Novel IC Architectures

Particularly circuits and architectures for future compute, e.g. neuromorphic, and cryo-CMOS (quantum), modelling cybersecurity by design, and design for future power electronics, to the point where we can scale all these designs into viable systems.

Realising Hybrid and Heterogenous Systems

Particularly the design, development and integration of silicon photonics (necessary for neuromorphic and quantum compute) and sensors for manufacturing, medical, agricultural, environmental, energy, and other applied sectors; chiplets, System on Chip (SoC), and System in Package (SiP), e.g. co-packaged optics for future AI, comms, and big data; and advanced packaging for power electronics.

A multidisciplinary UK research community aligned to this theme must be fostered, promoting R&D on seamless integration of diverse semiconductor components and technologies; and the cognate critical supply chains engaged.

2 Prototyping

In the urgent interests of national security, the UK should establish and maintain prototyping across the TRLs, specifically (a) at low TRL level, academic facilities for proof of concept, (b) at mid TRL level, three to four new distributed national facilities, and (c) at high TRL, pre-production capability via a national facility with the equipment (deposition, etching, lithography, implantation) required to make prototype devices. For this, the UK should use best practice international models, such as the South Korea's Ministry of Science and ICT's National NanoFab Center; or a version of IMEC's renowned facility in Belgium.

The focus is scaling to pilot, making available real manufacturing tools in fabs designed on industrial principles, in support of manufacturing; creating a physical RD&I infrastructure and ecosystem, within which researchers, start-ups, and SMEs can demonstrate technology to build value.

Specifically what type of small-scale capability, or what type of prototyping facility, should be scoped strategically as a follow-on activity from this research and should align with the Priorities in Recommendation One. Feasible examples could include immersion DUV lithography; discrete analog and power; and packaging and integration. These facilities should also be designed to consider the overarching challenge of sustainability of semiconductor manufacturing and circularity; as well as providing the prototyping capabilities to enable a full green transition.

In addition, the UK Government must continue to invest in key infrastructure facilities that are strategically aligned to industry needs, to provide a route to scale up; fully utilising and building upon the investments that have been made. They must launch a funding programme by which current and future semiconductor R&D equipment within universities and national facilities can be rapidly repaired and/or replaced.

From a national security perspective, serious and urgent thought needs to be given to establishing a **small-scale silicon manufacturing capability** (90-22nm), specifically for the types of R&D that are necessary to national security.

As well as significantly boosting the resilience of UK supply - and bolstering the UK against external threat - such facilities also represent high economic growth potential. Based on UK expertise in advancing materials and in design, the UK could be a world leader in making devices. Such centres would take the UK's fantastic research in materials, in design and in modelling to the pre-production level necessary to turn quality research into quality commercial products. This is a major opportunity.

3 Communities of Practice

The UK should roll out a substantially increased and ambitious programme of R&D grants specifically for semiconductors, eliminating silos and enabling collaboration, establishing communities of practice and growing clusters of strength; complemented by the co-ordination and support model provided by Network+ grants.

Significant consideration should be given, in the design of this funding, to:

- How it enables collaboration
- How it allows successful research projects to evolve and grow over time
- How it supports planetary health
- How it bolsters the domestic development of a sustainable semiconductor industry.

R&D funding must be properly connected with Innovation funding, as happens in most European contexts (e.g. Photon Delta in the Netherlands).^[27]

UK R&D funding should seek to grow high quality cluster ecosystems, driven by the recommended Communities of Practice, all aligned to the **three priority areas** defined in Recommendation One.

[27] <https://www.photondelta.com/>

4 Securing Talent

The UK must materially improve the proposition for researchers to remain in UK academia.

There is currently an industry/academic salary difference of around 3:1. Furthermore, even within academic salary scales, the UK package is extremely uncompetitive. The leading software companies (for example Google, Meta, OpenAI) are all currently establishing dedicated hardware (semiconductor) teams, and so the competition to retain talent within academia is high, as is the need to be able to supply companies considering a starting or retaining a base in the UK with UK-based talent.

UK universities are a key national asset, but such stark salary discrepancy undermines the very future of this asset.

Current salary levels pose immediate threat to both recruitment and retention, particularly in buoyant areas such as silicon photonics, or electronic design at the interface. An urgent growth in workforce is critical for the UK to generate future R&D, as well as to rapidly increase the pipeline of skills that are needed to support the economy across the technology domains. Furthermore, improving the UK offer would also enable the UK to attract international academic expertise to research here.

The UK must provide the conditions that enable a pathway for academics to 'spin out' - commercialise their research - without having to completely leave academia.



James Watt Nanofabrication Centre at the University of Glasgow

5

Growing Skills and Jobs

Significant consideration needs to be paid to realising the retraining opportunity, potentially re-employing talent from declining industries; as well as the need to train and grow the semiconductor workforce throughout the technical levels, which is what both academia and industry need.

The UK should establish a new model of doctoral training across the core semiconductor topics as well as allied emerging topics (e.g. neuromorphic, quantum, photonics, packaging, sustainable electronics, and system design).

This national PhD programme must, by 2030, be collectively training up at least 150 PhD researchers a year.

This will require allocated novel funding to support these studentships, and the associated expenses; including to provide the students with semiconductor research services equivalent to those available, for example, to students in China; and enable the PhD cohorts, crucially, to design and fabricate test chips.

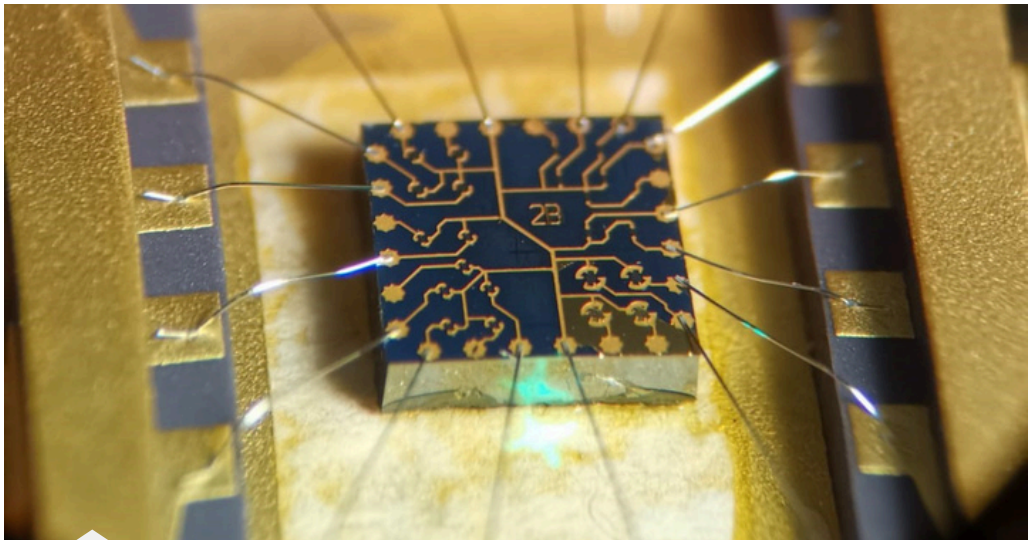
The aggregation of resources would improve lecturing and upskilling, for example, via an online teaching platform for students/researchers taking part in the national PhD program, to share expertise across institutes, foster the collaboration model in our early career researchers, and eliminate barriers caused by travel distances across the UK.

6 Commercialisation

The UK Government must liaise with the higher education sector to advance economic growth in semiconductors by reducing the IP burdens placed upon academics by their institutions.^[28]

Organisations such as InnovateUK and ChipStart could help accelerate commercialisation of university research by attracting VC investment; including through a place-based and/or match funding approach that can be activated across the UK, particularly in the regions.

Careful consideration should be given to establishing a EUROPRACTICE initiative for UK-based semiconductor businesses.^[29]



Diamond Microhotplates fabricated by Cardiff Diamond Foundry at Cardiff University

[38] For example, see ARIA: <https://www.aria.org.uk/how-we-fund/faqs>

[29] "The EUROPRACTICE platform nurtures the growth of a microelectronic design ecosystem in Europe thanks to a coordinated brokerage service for industry and academia looking for affordable and easier access to electronic smart systems technologies" based on Tools, Technology, and Training. <https://europactice-ic.com/>

7 Organisation

Establish a **lightweight** national organisation for semiconductors, however **this should not be established at a cost that could risk the implementation of other more pressing semiconductor R&D investments (e.g. prototyping facilities).**

Such an organisation should be designed to deliver specific and measurable impacts. It should not seek to duplicate existing successful and economically viable models (e.g. the EPSRC Networks); and must **align with the thematic research priorities outlined in Recommendation One.**

Potential services such an organisation could provide include:

Providing a centralised, real-time status function on national semiconductor R&D facilities, including a transparent, easy, and accessible digital platform to arrange access.

Developing, with UK academics, a bold curriculum on semiconductor skills.^[30]

Undertaking strategic, ambitious, and imaginative public campaigns to tell the story of semiconductor technology and its applications; to (i) raise awareness of the need for public spend in this sector, (ii) attract talent to the sector and, (iii) attract investors.

Attracting existing semiconductor manufacturers to invest in legacy plants in the UK, including by offering Government support, as other industrial nations are currently doing.^[31]

Working in partnership to ensure that hardware made in, and hardware used in, the UK is secure-by-design, to ensure a more secure digital future.

Co-creating, with researchers and practitioners, high-quality decadal visioning and positioning strategies.

[30] "The Welsh Joint Education Committee (WJEC) is the first UK awarding body to develop semiconductor qualifications as a pathway to the industry. These new qualifications, developed in partnership with industry, including CSconnected, became available to learners in 2024" <https://csconnected.com/media/t52dosq5/weru-csconnected-sipf-2024-annual-report.pdf>

[31] For example, currently the UK has to buy all its CMOS chips from abroad, including from China. This leaves it extremely vulnerable as a nation. If the Government could support a manufacturer to acquire a plant which might produce a domestic supply of legacy CMOS chips (22nm-90nm on 200mm-300mm wafers), this would be a significant improvement to the UK's defence and security position.