Cardiff University
Prifysgol Caerdydd
Welsh Economy Research Unit
Yr Uned Ymchwil i Economi Cymru

Talent, Skills and the Semiconductor Industry

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Welsh Economy Research Unit
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This case report was written by Mark Lang, Jin Ho Kim, Max Munday, and Porjai Chalermsook

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Case summary

This is the sixth in a series of case studies to support the CSconnected Strength in Places Fund (SIPF) project, funded by UK Research and Innovation. The case study explores the critical role of skills and talent in the semiconductor industry, with a particular focus on the compound semiconductor cluster in Wales. It underscores the symbiotic relationship between skills supply and demand, emphasising that an adequate supply of local skills is the most critical factor determining investment and growth in advanced manufacturing industries like semiconductors. The semiconductor industry's need for constant innovation makes it highly dependent on a qualified workforce, and shortages in appropriate skills can impede investment and undermine existing industries.

The case study investigates skills supply and demand issues within the context of the Welsh semiconductor cluster, examining themes such as the global skills and talent challenges, regional issues affecting the Welsh cluster, and the role of skills development initiatives. It identifies a major shortage of STEM students and graduates, too few of whom subsequently pursue careers in semiconductors, which is a significant concern for the industry's future. The case study also discusses the complex governance of the skills supply and demand interface, the underdevelopment of approaches to training such as apprenticeships, and the importance of ongoing professional development for current industry employees, to support and enhance productivity and future growth.

Although several successful semiconductor skills initiatives in Wales are clearly identified, the visibility of the semiconductor industry as a locally significant career choice remains low. The study highlights the importance of addressing skills shortages and talent pipeline issues to support the future sustainability and growth of the semiconductor industry in Wales and beyond. It recommends the critical need to improve the uptake of STEM subjects, raising awareness of semiconductor careers, and further enhancing coordination between industry and skills and education providers, within a strengthened regional skills and industrial policy landscape.

The following recommendations are proposed:

1. Invest in STEM education
2. Further develop apprenticeship programs
3. Continue to promote industry-specific training programs
4. Increase the visibility of semiconductor careers
5. Support and further enhance ongoing professional development
6. Facilitate international talent recruitment where appropriate
7. Enhance coordination between education providers and industry
8. Strengthen regional skills ecosystems

1. Introduction

An adequate supply of local skills is a critical determining factor influencing investment and locational choices in the advanced manufacturing industries. An appropriately qualified labour force is the most critical determinant of the longer-term growth trajectories and productivity of individual firms within such industries. Given the nature of its manufacturing processes and its need for constant innovation, the semiconductor industry is, perhaps, one of the clearest examples of this symbiotic skills supply and demand relationship. In short, skills are *a priori* in discussions about firm, cluster, and industrial growth.

Even where locational decisions are supported by significant capital and other state incentives, efforts to grow semiconductor manufacturing in 'new' or existing places can often be delayed, or frustrated entirely, by the insufficient availability of a suitably qualified local workforce. This has, for example, been as frustrating a factor in delivering manufacturing expansion plans in Arizona (TSMC) following from the Biden era US Chips Act as it has elsewhere (FT, 7.10.24). Japanese firm Rapidus, for example, is facing similar skills blockages (FT, 4.12.24).

The skills supply dynamic is particularly evident when regions aim to attract new investment and expand their semiconductor industries. Even in cases where regions seek to maintain their existing industries, having a steady supply of talent remains crucial, as does the ongoing professional development of current employees. This is often necessary due to attrition rates, which can be influenced by factors such as skilled industry employees being recruited by firms in other technical sectors, moving to new places, or simply retiring.

Just as shortages in appropriate skills may impede the movement of semiconductor firms into new locations, the sometimes uncertain nature of regional investment decisions by firms themselves may frustrate efforts by regional skills providers to design and implement new training programmes. They may also severely limit the stream of training programmes that require longer-term commitments such as apprenticeships. Global geopolitical and economic uncertainties have increased significantly over recent years and, consequently, firm location decisions have becoming more uncertain. It is important to note, therefore, that skills supply and skills demand is a two-way relationship – firms need certainty over skills and talent supply, while training providers need a degree of predictability over skills demand.

1.1 Purpose of Case Study

This case study seeks to investigate skills supply and demand and talent pipeline issues within the context of the compound semiconductor cluster in Wales.

It explores several interconnected themes as follows:

- The skills and talent pipeline supply and demand factors likely to influence the future development of the global semiconductor industry.
- Specific regional issues that may impact the future growth of the compound semiconductor cluster in Wales.
- A consideration of how far productivity growth might be supported within the UK semiconductor industry and Welsh cluster by skills development initiatives.
- A reflection on how skills development programmes might help facilitate increased networking and sharing of best practice.

- A review of regional talent pipeline issues facing the future of the Welsh cluster firms.
- A brief case on the role and achievements of the CSconnected CPD initiatives.

1.2 Methods

This case study is based on a contextual literature review, an analysis of statistical data from the ONS, an analysis of secondary grey data, and a series of semi-structured interviews with members of the CSconnected Educational Group (CSEG) and other cluster partners. Table 1 identifies the organisations that were engaged as part of this research.

Table 1.1: Case study interviews

Organisation	Date Completed
Cardiff University Academic Lead	March 2025
Cardiff University CPD Team	March 2025
CSA Catapult	April 2025
CSconnected	March 2025
KLA	March 2025
Microchip	March 2025
Swansea University Academic Lead	March 2025
Vishay	April 2025

1.3 Structure of report

The following section reviews the relevant grey and academic literature on the current skills and talent pipeline issues in the global semiconductor industry. It also provides a brief overview of the UK semiconductor industry's specific challenges. Section three synthesises the findings from interviews with members of the CSconnected Educational Group and offers an overview of Welsh regional semiconductor skills and talent pipeline initiatives. Finally, section four summarises the core findings and proposes some tentative recommendations based on this case study.

2. Talent, skills, and semiconductors

2.1 The global semiconductor industry

A sufficient supply of workforce talent, and an appropriate blend of skills provision, have been widely acknowledged to be major contributory factors in the success of the semiconductor industry, as well as an essential requirement for its future sustainability and growth (Xiong et al., 2024). Alongside a high degree of investment in research and development at an industrial policy level, a long-term commitment to developing industry appropriate talent and skills has been credited as a major causal dynamic in those countries that have witnessed the most significant growth of domestic semiconductor industries over recent decades (Chang et al., 2021).

Whereas talent supply and skills provision have been critical in driving growth in the semiconductor industry, conversely, shortages of either or both have negatively impacted the industry, often holding back development even in well-established national industrial contexts (Silverberg and Hughes, 2021). As illustrated in Table 2, the latest CSconnected annual report (Munday et al., 2025) identified insufficient labour and skills supply as the most critical risk factor currently facing the global semiconductor industry.

Table 2.1: Global semiconductor industry risk register

Risk	Risk Description	Likelihood	Impact	Risk Score	Mitigation Measures
R1	Increased geopolitical tensions (supply chain and raw material disruption).	4	3	12	Diversifying supply chains, stockpiling, growth of regional clusters, investment in domestic production.
R2	Increased export controls, tariffs, and blacklisting.	4	3	12	Diversifying supply chains, stockpiling, political/policy advocacy.
R3	Reduced financial and other investment (state and industry)	2	4	8	Focus on innovation, international collaboration, political/policy advocacy.
R4	Wider economic downturn (affecting end markets).	2	5	10	Diversifying products, increased manufacturing responsiveness.
R5	Lower than forecast downstream demand for semiconductors.	3	5	15	Diversifying products, market expansion, customer engagement.
R6	Insufficient labour/skills supply (including replacement skills).	4	5	20	Investment in future/replacement skills provision, political/policy advocacy.
R7	Environmental impact (regulatory compliance requirements).	2	3	6	Adoption of green manufacturing processes, investment in R&D, employee training.

Likelihood (probability of the risk occurring 1 [not very] – 5 [very]); Impact (consequences should risk occur 1 [minimal] - 5 [severe]); Risk Score (likelihood score x impact score).

In 2023, the European semiconductor industry collectively employed around 380,000 people, and projected production growth is expected to add over 150,000 new jobs by 2030. These anticipated additional job openings, when combined with expected replacement of retirees, will lead to over 270,000 job openings in core technical roles across Europe over this period. Critically, however, on current trajectories it is not expected that the number of graduates entering the EU semiconductor industry will significantly increase. (Beaujeu et al., 2024; Pele, 2024). Europe is not alone in experiencing these forecasted shortages of future talent, as other major semiconductor industries face similar shortages. South Korea, for example, is expected to face a shortage of at least 30,000 workers (Xiong et al., 2024). As the supply of suitably qualified and skilled labour falls further short of demand, the talent gap in the global semiconductor industry is, thus, expected to grow significantly over the coming decade.

The current growth trajectory of the global semiconductor industry, which is being largely driven by increasing digitisation and connectivity, is a major factor in driving the current and anticipated increased demand for workforce talent and has, thus, led to significant new job openings. The industry's growth is serving to exacerbate existing talent shortages as demand for workers with the right skills continues to outstrip supply. Indeed, the availability of skilled labour is an essential prerequisite for industrial growth. Moreover, as the shortages experienced by the semiconductor industry are replicated across whole economies, the competition between industries requiring a similar skill mix for the available pool of talent is only likely to increase (SIA and Oxford Economics, 2023).

Skills demand within the semiconductor industry may be particularly accentuated by the phenomenon of Moore's law – the prediction that the number of transistors on a chip roughly double every two years leading to a significant growth in computing power over time – which drives rapid technological change. Consequently, as semiconductor technology continues to advance, so to do the most in-demand skills, which must evolve in-line with new areas of research and product development (Brugmans et al., 2024). As the industry consequently becomes more complex, skills shortages become more pronounced (Burkacky at al., 2022). These talent shortages are likely to extend into all areas of the semiconductor value chain (Brugmans et al., 2024; Rizi, 2023), but are likely to impact most significantly on specific pinch points.

Whereas a well-developed existing regional spatial ecosystem can support the cross-pollination of workforce talent supply and skills training provision across firms (Brugmans et al., 2024), shortages are often nevertheless experienced when new investments or expansions are planned. Shortages are particularly prevalent when seeking to establishing semiconductor industrial activity in new places, and it is exceptionally difficult to start new activity, and particularly constructing and operating a new FAB, with newly qualified talent alone (Neufeld, 2022). Thus, skills are *a priori* in the context of economic policy decisions within this context.

To help frame the issues considered in this case study, it is important to distinguish between workforce talent and skills supply. Within this context, workforce talent refers to the available or potential pool of suitably qualified and motivated people within a given spatial location that may be accessible to the industry. Whereas skills supply refers to the mechanisms and structures available to develop specific capabilities required by the industry now and as it develops further. Brunello and Wruuck (2019) distinguish between skills mismatches, shortages and gaps. They suggest: 'skill mismatch at the macro level refers to the gap between the (aggregate) supply and demand for skills…'. Meanwhile, 'skill shortages arise when employers are unable to recruit staff with the required skills in the accessible labour market and at the ongoing rate of pay…', and '…skill gaps is often used when the skill levels of the existing workforce are insufficient to meet the requirements of firms…' (p. 4-5).

2.2 The talent pipeline

There are three broad technical occupational categories that account for over three quarters of employment in the semiconductor industry (Beaujeu et al., 2024), these are:

- Technicians (typically educated to HND or foundation degree [5[1]], or bachelor's degree [6])
- Hardware and software engineers (with bachelor's [6] or master's degrees [7] and PhDs [8])
- Data specialists/computer scientists (with bachelor's [6] or master's [7] and PhDs [8])

In the US, where three quarters of semiconductor industry employees are employed in technical roles, the industry is forecast to experience a 39 percent shortage of technicians, a 20 percent shortage of engineers, and a 41 percent shortage of computer scientists by 2030 (Semiconductor Industry Association [SIA] and Oxford Economics, 2023). Talent shortages are, however, already being experienced. Between 2021-23, in the European semiconductor industry, for example, 30 percent of technician, 54 percent of hardware engineer and 13 percent of software engineer, and 3 percent of data analyst posts remained vacant as employers were unable to recruit suitable workforce talent. On current trajectories, by 2030 these unfilled posts are expected to increase to 31 percent, 52 percent, 11 percent, and 6 percent respectively (Beaujeu et al., 2024).

Whilst one in five semiconductor industry employees are educated up to ISCED (Industrial Standard Classification of Education) level 5, shortages are typically more acute at levels 6 and upwards (Silverberg and Hughes, 2021). Whereas the EU, for example, is third globally in the number of STEM graduates it produces each year (behind China and India, but ahead of the US), only about 20 percent of these are in semiconductor-related disciplines, and, of these, just 6 percent will take up employment the EU semiconductor industry (Beaujeu et al., 2024). Talent shortages are, then, frequently cited as the most significant issue facing the global semiconductor industry (Allen, 2023; Munday et al., 2025).

As well as being driven by an insufficient number of students pursuing STEM subjects more generally, including too few of these progressing to post-graduate study, too many STEM graduates subsequently take up non-STEM occupations. In addition, replacement workforce talent demand is also a major contributory factor to the semiconductor industry's shortage (SIA and Oxford Economics, 2023). In 2023, it was calculated that one third of US semiconductor employees were aged 55 or over, whilst across the EU the same demographic was put at one fifth of the workforce (Brugmans et al., 2024). The impact of retirees on driving replacement demand has also been identified as a major concern in relation to the Welsh compound semiconductor cluster, and in 2018 it was found that around half of industry employees in the cluster were likely to retire over the subsequent 10-15 years (Edmondson, 2018). Demographic trends are, thus, a major factor that can accentuate talent shortages (Brunello and Wruuck, 2019).

Whereas the shortage of technician talent may more readily and locally be addressed, although this will vary according to the specific job role, it is likely that addressing the shortages of engineers and computer scientists will take a minimum of 10-12 years (Edmondson, 2018). Addressing the shortage of engineers requires a long-term investment and a broad-based approach. Such an approach may, for example, include targeted education campaigns, scholarships, research fellowships, hands-on experiences, and support for university engineering programmes and new facilities (SIA and Oxford Economics 2023). Table two summarises a range of potential interventions that may support future talent pipeline development in the semiconductor industry.

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[1] Industrial Standard Classification of Education (ISCED).

Table 2.2: Workforce development initiatives to create a pipeline of talent

Primary/Secondary School	FE College	University	Industry Transfer
STEM career guidance by industry professionals	'Learn and earn' for entry level workforce	Scholarships with research and mentoring	Career awareness for veterans
Modernise curriculum in line with industry demands	Industry funded training courses for in-demand areas	Industry sponsored recruitment events	Targeted manufacturing related training
Direct workforce entry through apprenticeships	Public funded programmes for experimental learning	Expansion of advanced coursework for in-demand areas	Reskilling programmes
Closer links with universities	Industry-endorsed 'bootcamps'	Domestic postgraduate scholarships	More remote training provision

Source: Rizi (2023) [modified]

It has been suggested that the semiconductor industry has an image problem with regards to attracting potential new recruits, both in terms of work-place attractiveness and visibility of the industry as a place to build a career (Burkacky at al., 2022). Raising semiconductor industry career awareness is, therefore, an essential requirement for addressing the talent shortage. The UK semiconductor industry is not immune from this broader trend, where it is believed that the challenges of the industry recruiting technical roles is compounded by competition from industries requiring similar workplace talent with higher profiles (Institute of Physics and Royal Academy of Engineering, 2022). Industry career visibility is a wider phenomenon than one experienced within the UK. In the US, for example, one of the central workforce aspects of the Biden era Chips Act was concerned with the need to address the lack of brand awareness of industry companies (Rizi, 2023).

Critically, there is a need to improve the uptake of STEM subjects and to instil a greater awareness of the semiconductor industry earlier in the learning curve (Gunarathne and Chaitanya, 2024). There is a need for better coordination between universities, FE colleges, schools, and the needs of industry, to improve the semiconductor talent pipeline (Institute of Physics and Royal Academy of Engineering, 2022). Investment is needed in schools, for example, to raise awareness and stimulate interest in electronics (particularly at primary school level) and semiconductors (at secondary schools). Overall, there is a need to scale up current efforts, possibly as part of a national programme, and provide financial support to encourage greater diversity among students, including the further uptake of semiconductor industry opportunities for women (Tech Works, 2024). Joint strategies with other industries requiring similar skills sets may be one means of assembling sufficient resource to achieve these aims.

2.3 Skills

It is important to note that there are both economic and social costs associated with regional skills weaknesses. Whilst, for firms, limitations in skills negatively impact productivity and innovation, for individuals lacking the 'right skills' limits employment options, career progression, and, ultimately, earning potential. The availability of an appropriately skilled workforce is also, as discussed, a frequently sighted obstacle to future investment by semiconductor firms (Brunello and Wruuck, 2019).

As previously indicated, it is important to distinguish between skills mismatches, skills shortages, and skills gaps. Skills mismatches relate to the macro level gap between the supply and demand for skills within a particular region or country. Skills shortages relate to the inability of employers to recruit sufficient talent with the necessary skills at the going rate of salary. Skills gaps refer to the situation where the skill levels of an existing workforce do not sufficiently meet the requirements of firms. (Brunello and Wruuck, 2019) There appear to be three central strands to skills development: secondary education and increasing the uptake of STEM subjects; higher education (bachelor's and master's degrees, and PhDs); and on-the-job training, CPD, and lifelong learning (IMEC, 2025). Investments in STEM subjects are important for the future skills supply in the semiconductor industry, but it is important to note such investments are not quick to deliver returns in terms of future talent (Neufeld, 2022).

The potential solutions to boost skills provision often depends on the job role affected. As the jobs market for technician roles tends to be more localised, skills training for technicians is, correspondingly, also likely to be localised. In many cases this will be centred on a relationship between employers and further education colleges or regional private sector skills training businesses. In the US, it has been suggested that too few people take up training opportunities in technical colleges to obtain the skills they need for technician roles in advanced manufacturing facilities (SIA and Oxford Economics, 2023). This is likely to be the case elsewhere, including the UK.

For engineer and computer science professionals, more likely to be educated to ISCED level 6 or above, boosting skills provision is likely to be more complex and delivered over a longer-term period. Short-term interventions might include upskilling and reskilling existing workforces, as well as attracting and facilitating international talent. Meanwhile, long-term interventions may include expanding and adapting academic and iVET programmes, as well as promoting the sector as a career choice at different points in the student academic journey. Paradoxically, there are indications that, in some places, universities may find difficulties in recruiting technicians to run and maintain equipment within campus settings, just as, in further education, colleges sometimes experience challenges to recruit lecturers in relevant fields (Institute of Physics and Royal Academy of Engineering, 2022).

One particularly useful means of boosting skills provision for employers is the use of apprenticeships and degree apprenticeships. Previous surveys have indicated the use of apprenticeships by semiconductor companies, including those in Wales (Edmondson, 2018). Apprenticeships help accelerate development of workforce competence and help enable specialist vocational routes, and assist in progressing talent pipelines (Tech Works, 2024). Thus far, however, the availability of apprenticeships within the industry have been relatively modest.

Apprenticeships are a particularly helpful mechanism of ensuring specific vocational knowledge, but the coordination of curriculum content and more hands-on experience to supplement theory elements of more traditional academic routes are also important (Gunarathne and Chaitanya, 2024). It has been argued there need to be greater opportunities for university students to develop the specific know-how needed in semiconductors (such as in Chip Design) and to gain work experience in the industry (Tech Works, 2024). Paid internships may assist in this respect. Specialist Master's courses might also help, but these are generally unfunded for students and can sometime rely on international students to fill numbers (Institute of Physics and Royal Academy of Engineering, 2022).

In some respects, with the pace of technology change within the semiconductor industry, as we have seen, it is increasingly difficult to produce graduates with all the skills needed for careers in the industry. The role of continuous professional development (CPD) has therefore grown in significance for the industry (Allen, 2023). Alongside this, the usefulness of conversion courses to enable people from other related industries to transfer into semiconductors is also increasingly apparent as the industry demand for talent continues to grow (Institute of Physics and Royal Academy of Engineering, 2022).

2.4 International talent

There is significant international competition for talent in the semiconductor industry. The semiconductor industry has become dominated by countries and companies that have attracted the best talent. This is partly because the mobility of engineers and other experts provides an effective means for companies and counties to acquire outside knowledge spillover and technology (Palomeras and Melero, 2010). In 2022 it was estimated, for example, that 63 percent of STEM graduates working in the US semiconductor industry were international talent (Neufeld, 2022). Conversely, more recently, there have been excess outflows of semiconductor industry engineers from the US, Taiwan, Japan, and Germany, and excess inflows into China and South Korea (Fujiwara, 2023).

Immigration policy is therefore a significant consideration for the industry (Dally and Su, 2022). In the UK, it has been noted that problems may exist in recruiting overseas talent caused by the UK's visa and immigration system. Brexit has, it has been suggested, also made it significantly harder to recruit talent from the EU. This may have also impacted on efforts to retain international talent educated in UK universities after graduating (Institute of Physics and Royal Academy of Engineering, 2022). This difficultly is not restricted to the UK as, for example, a high proportion of US graduates and, particularly, post-graduates in relevant subjects are international students who leave the country after graduating (SIA and Oxford Economics, 2023). This is often because there is an expectation that many of these graduates return to their own countries, at least for a period, in return for sponsorships they have received.

According to Canayaz et al. (2024), US policies from 2018 resulted in a decrease in the hiring of domestic talent, particularly at entry-level and junior positions, within the US semiconductor industry. They suggest that one reason for this decline may be that as international talent leaves, prospective domestic workers may feel less inclined to join these firms. Generally, top talent, whether domestic or international, prefers to work for the most successful companies that attract international talent. Additionally, international talent can contribute to training the next generation of domestic talent (Neufeld, 2022). Therefore, protectionist policies that limit firms' ability to recruit internationally may also affect their capacity to recruit and train domestic talent.

2.5 Regional skills agendas

Since the 1960s skills have been regarded as foundational to productivity and economic growth (see, for example: Schultz, 1961). Yet, despite a growing recognition of the importance of public policy skills agendas, advanced economies have continued to experience significant skills shortages, skills gaps, and skills mismatches. Too often, skills decisions are taken only after other investment decisions have been made. This may also be explained because of policy-makers conflating education and skills policies. There is also a strong spatial dimension to these policy debates, as skills are widely conceived as essential for regional industrial transformation (OECD, 2019). Despite an increasing awareness of the need for greater specificity in understanding regional skills needs, regional studies literatures have yet to fully explore these themes.

It has been argued that the successful construction of integrated frameworks for regional skills policy, rests on connecting stakeholders involved in regional skills ecosystems, with those actors and agencies charged with defining regional development strategies (Corradini et al., 2023). This, it is suggested, should be a dynamic process of closely matching skills supply and demand in support of improved productivity, innovation, and competitiveness. This process, Corradini et al. propose, should be the basis for smart specialisation and regional industrial branching. Nevertheless, research into employer responses to skills policy agendas and ecosystems, particularly at a regional level, has remained limited, and regional policy and skills policy agendas have in many instances yet to fully integrate.

The EU Chips Act proposed 'competence centres' in each member state, for example, but there are fears this may have diluted Europe's efforts to support talent development most required. Thus, it is suggested, it might have been more advantageous to concentrate efforts in those regions where there is an established and successful semiconductor industry cluster (Duchâtel, 2022). Consequently, it has been suggested that European semiconductor industry policy should not be place neutral, but should instead focus on supporting innovation and enterprise in those regions that already have specific strengths. Such an approach would enable a 'triple helix' model of policy development involving government, industry, and academia (Johnston and Huggins, 2023). Local mediating partnerships of employers and regional training providers can, therefore, play an important role in fostering firm performance and regional economic development (Suleman et al., 2023).

A consistent and recuring theme in policy debates has been a widely recognised need for closer links and partnerships between industry, training providers, and universities to ensure courses reflect the needs of industry (Allen, 2023; Burkacky et al., 2022; Gunarathne and Chaitanya, 2024; Tech Works, 2024). Some governments are investing significant resources into supporting the uptake of relevant courses and promoting strategic partnership approaches between industry and skills and education providers (see, for example: Government of the Netherlands, 2024). Others have also proposed helpfulness for joint strategies with other industries requiring similar skills sets (Woods and Gajjar, 2024).

2.6 Summary

The preceding analysis has highlighted several challenges and concerns related to the skills and talent pipeline within the global semiconductor industry. In the section below, these issues are examined in greater detail with a particular focus on the Welsh cluster, setting the context for the research interviews.

Global Skills and Talent Challenges

- Expected shortfall between labour demand and labour supply.
- The existence of pinch points in skilled labour provision.
- Training responses differ for occupational categories.
- Major shortage of STEM students and graduates.
- Complex governance of skills supply and demand interface.

3. UK and Welsh Semiconductor Industry Workforce

The importance of strong evidence to guide policy development is paramount. The UK Government is currently seeking to enhancing its skills evidence base to support the implementation of the National Semiconductor Strategy.

Recently, the Department for Science, Innovation and Technology released a UK semiconductor workforce report (Perspective Economics, 2025) to aid in this effort. The report found that the UK semiconductor workforce is regionally distributed across several clusters with approximately 27,245 individuals, where 69% are employed in technical roles. Despite a highly educated workforce, challenges include an aging demographic with 39% expected to retire within 15 years, limited gender diversity, and a low prevalence of apprenticeships or foundation degrees. The report identified what it suggested were several semiconductor sector education and pipeline challenges, including plateaued domestic graduate inflows, uncertain international student retention, misalignment of university courses with industry needs, and underutilisation of vocational and apprenticeship pathways.

The availability of comprehensive and pertinent data poses a significant challenge in comprehending employer skills requirements. Frequently, data accessibility is confined to aggregated sectors, necessitating inferences for more specific sectors (and see below). Additionally, there are difficulties related to obtaining data at an appropriate geographical scale, as well as acquiring data within a reasonable timeframe to inform current analyses effectively.

3.1 Employer Skills Survey

The Employer Skills Survey (ESS) is a large-scale, nationally representative survey that provides insights into employer demand for skills, recruitment issues, workforce development, and training across UK industries. A key limitation of this dataset is the small sample size for the semiconductor industry (typically contained within SIC 26110 Manufacture of electronic components). Therefore, Tables 3.1 to 3.5 focus on the broader manufacture of computer, electronic, and optical products industry (SIC 26), which shares some features with the semiconductor sector. Table 3.1 shows UK vacancies by occupation within SIC 26, while Table 3.2 highlights the percentage of hard-to-fill vacancies in Wales and the UK overall.

Table 3.1: UK Distribution of Vacancies by Occupation (%), Manufacture of computer, electronic, and optical products (SIC 26)

Occupation	UK (2019)	UK (2022)
Managers	-*	-
Professionals	17	14
Associate professionals	21	18
Administrative/secretarial occupations	10	7
Skilled trades occupations	22	23
Caring, leisure and other services occupations	-	-
Sales and customer services occupations	-	14
Machine operatives	19	17
Elementary occupations	4	4

Source: Employer Skills Survey. ** Indicates figure based on a small sample size and not authorised for publication*

Table 3.2: Share of Vacancies Classified as Hard-to-Fill (%), Manufacture of computer, electronic, and optical products (SIC 26)

Year	Wales	UK
2019	44	43
2022	43	49

Source: Employer Skills Survey

The EES also provides data specific to Wales, indicating that in 2019, 48% of all vacancies in Wales were for associate professionals, which was higher than the UK average of 21% for that year (see Table 3.1). Additionally, while professionals constituted 17% of total vacancies in the UK in 2019, Wales had a lower proportion in this category. Machine operatives represented 19% of all vacancies in the UK in 2019, but the share was slightly higher in Wales. By 2022, machine operatives made up the largest share of vacancies in Wales at 43%, exceeding the UK average of 17%. In comparison, vacancies for professionals, associate professionals, and skilled trades in Wales followed trends similar to those across the UK.

The data shows a shift in occupational demand within SIC 26 in Wales towards technical and production roles, indicating a more manufacturing-oriented profile. Additionally, an analysis of activity in SIC 26110 reveals that in 2019, the percentage of Welsh establishments reporting vacancies in skilled trades was nearly three times higher than the UK overall. The percentage reporting vacancies for professionals and machine operatives was roughly double the UK average.

Table 3.3 highlights the main reasons for hard-to-fill vacancies in the Manufacture of computer, electronic, and optical products industry (SIC 26). Skill shortages were the most common cause, followed by a low number of applicants and lack of relevant experience. Although access to data for SIC 26110 is restricted, analysis suggests that in Wales, key issues include few skilled applicants and remote locations.

Table 3.3: Main Causes of Hard-to-Fill Vacancies (% of Establishments), Manufacture of computer, electronic, and optical products (SIC 26)

Cause	UK (2019)	UK (2022)
Low number of applicants with the required skills	70	39
Low number of applicants generally	-*	25
Lack of work experience the company demands	29	23

Source: Employer Skills Survey. ** Indicates figure based on a small sample size and not authorised for publication*

Table 3.4 outlines the impact of hard-to-fill vacancies. A majority of UK establishments reported increased workloads for staff in both 2019 (90%) and 2022 (96%). Additionally, there were delays in product development (49% in 2022) and difficulties in meeting customer service goals (63% in 2022). Furthermore, a notable minority experienced increased operating costs (43% in 2022).

Table 3.4: Impact of Hard-to-Fill Vacancies (% of Establishments), Manufacture of computer, electronic, and optical products (SIC 26)

Impact	UK (2019)	UK (2022)
Lose business or orders to competitors	51	33
Delay developing new products or services	51	49
Have difficulties meeting quality standards	29	27
Experience increased operating costs	43	43
Have difficulties introducing new working practices	30	33
Increase workload for other staff	90	96
Outsource work	49	25
Withdraw from offering certain products or services altogether	-*	20
Have difficulties meeting customer services objectives	60	63
Have difficulties introducing technological change	36	41

Source: Employer Skills Survey. ** Indicates figure based on a small sample size and not authorised for publication*

Table 3.5 reports the main barriers to providing more training. In Manufacture of computer, electronic, and optical products, 51% of UK businesses in 2019 cited a lack of funds as the primary barrier to training, but this percentage decreased to 27% by 2022. Concurrently, concerns about releasing staff for training increased from 36% to 51%, reflecting operational pressures. In SIC 26110 (Manufacture of electronic components), time constraints and financial limitations were also significant barriers in 2019. Additionally, businesses in Wales faced difficulties in organizing training and reported a lack of suitable training options.

Table 3.5: Barriers to Providing More Training (UK % of Establishments), Computer & Electronics (SIC 26)

Barrier	UK (2019)	UK (2022)
Lack of funds for training / training expensive	51	27
Can't spare more staff time (having them away on training)	36	51
Hard to find the time to organise training	11	21
COVID-19 meant that planned training courses were suspended / unavailable	*	10

Source: Employer Skills Survey. ** Survey question not asked*

3.2 The Welsh Cluster

Tables 3.6 and 3.7 show that the Welsh cluster has grown significantly since 2019 and with activity recently boosted by new inward investments made by Vishay International and KLA. Expansion continues with increased activity from companies like Cadence Design Systems, Siemens, and Ffotoneg. Table 3.6 also reveals the indirect employment supported by the CS cluster and with elements of this in the local supply chain to the main manufacturers in the cluster. Table 3.7 reveals that the majority of employees in the cluster are resident in Wales, and also reveals a relatively high proportion of employee roles are R&D facing, and with almost half of employees qualified to undergraduate degree level of above. The information in the Table also reveals estimates of gross value added (GVA) per employee that have been shown to be well above the Welsh average in manufacturing.

Table 3.6: Direct and indirect employment in the Welsh CS cluster (FTE)

Year	Direct employment	Indirect employment	Total employment
2019	1,259	692	1,951
2020	1,407	678	2,085
2021	1,602	785	2,387
2022	1,737	878	2,615
2023	1,773	888	2,661
2024	1,806	942	2,748

Source: CSconnected Annual Survey Series

Table 3.7: Private sector elements of CS cluster (selected labour market variables)

Year	Direct employment	GVA per FTE employee	Resident in Wales (%)	Engaged in R&D (%)	Payroll	UG degree qualified (%)
2021	1,378	£131.1K	84%	19%	£70.8m	n/a
2024	1,602	£152.7K	87%	18%	£108.6m	47%

Source: Estimated from Annual Survey Series

Table 3.8, using data from the Annual Survey of Hours and Earnings, presents nominal and real wage differentials between Wales and other regions of the UK for the Manufacture of electronic components (SIC 26110), Manufacture of computer, electronic, and optical products (SIC 26), and Manufacturing sectors overall. The data shows that there is a nominal and real wage gap between Wales and the rest of the UK across all three sectors. It is important to note here that even in the case of manufacture of electronic components this includes many businesses not related to semiconductors. In this respect the average salary in the CS cluster was estimated at £60,110 in 2024 (mean gross annual earnings from ASHE 2024- £39,301). It has also been estimated that between 2021-24 there was 36% growth in average CS cluster salary compared to 20.3% growth in average full time earnings in Wales.[2]

Table 3.8: Nominal and Real Hourly Wages and Wage Gaps by Sector (2014–2018)

Sector	Wage Type	Wales	Non-Wales	Wage Gap
SIC 26110: Manufacture of electronic components	Nominal	12.17	14.32	-2.15
	Real	11.95	14.04	-2.09
SIC 26: Manufacture of computer, electronic, and optical products	Nominal	14.20	16.60	-2.40
	Real	13.94	16.28	-2.34
Manufacturing (overall)	Nominal	12.59	13.87	-1.28
	Real	12.34	13.59	-1.25

Source: Annual Survey of Hours and Earnings

2 See https://csconnected.com/media/t52dosq5/weru-csconnected-sipf-2024-annual-report.pdf and also prior annual reports on this link.

4. Key issues

4.1 Global issues and the Welsh cluster

The proceeding discussion has highlighted several important challenges that, if not adequately addressed, may significantly impact on productivity growth of the Compound Semiconductor Cluster in Wales. As established, the availability of an appropriately skilled workforce is critical for the future sustainability and growth of the semiconductor industry. It is the most critical risk factor facing the global semiconductor industry, and the most important risk factor identified in the latest CSconnected annual report (Munday et al., 2025). Current projections indicate a significant shortfall between future global semiconductor industry employment demand and the availability of suitably qualified talent supply across multiple countries. As the cluster is forecast to grow over the coming decade, so too is the critical need for skilled workers. Without these, cluster growth would appear to be unlikely.

The expected future growth of the industry, and its increasing technological complexity, is likely to accentuate labour market supply and demand dynamics, both globally and within the Welsh cluster. These challenges are likely to be experienced most significantly at pinch points of the semiconductor product chain and affect technical roles and levels of qualification demanded. With its emphasis on advanced compound semiconductor technology, the Welsh cluster will be particularly vulnerable to these pinch points. As established, three broad technical occupational categories (technicians, hardware and software engineers, and data and computer specialists) account for many roles within the global semiconductor industry. Each category tends to require particular types and levels of skills training, and, correspondingly, forecast shortages will vary between each category. Some categories are more likely to require international talent than others, whilst for others local talent will be more critical.

It should also be noted that, semiconductor manufacturing supply chains offer a broad range of opportunities for various skill sets particularly, for example, when compared with activities such as those involved in silicon design. The Welsh cluster benefits from significant skill set diversity due to its extensive involvement across multiple segments of the supply chain, encompassing materials, chip fabrication, chip packaging and sub-system integration, as well as capital equipment. With the entry of Cadence into the region design will also be added to this list. The targeted expansion of each of these supply chain 'nodes' is likely to beget more 'nodes' of skills demands in the wider economy. Some of these supply chain nodes match very well with Wales' historical strengths in foundational and tier one manufacturing in auto, aerospace, defence, and consumer electronics. Consequently, in some cases, Wales is likely to have a strong existing latent relevant skills base.

The proceeding discussion has also found that there is a major global shortage of students pursuing STEM subjects at every level of education, and of those that do too few subsequently pursue semiconductor industry occupations. This is an issue that is particularly likely to affect the Wales, but the wider UK is not immune from this trend. Such a finding places significant pressure on future talent pipelines that are critical for the industry, which is also facing major demographic challenges due to the high rate of expected retirees over the next ten years. A well-functioning skills development and talent progression infrastructure in Wales to supply industry labour demand is critical, as it is elsewhere. At one level this is related to industry-provider relationships, where uncertainty can impact on skills training provision, and on another level on the interface between skills and regional policy interfaces, where contextual evidence and close relationships between cluster partners is critical.

These challenges set the stage for the primary data collection that informed this case study. The research interviews, as detailed in Table 1 earlier, were structured to gather respondents' insights on these issues and their relevance to their experiences within the cluster and Wales. Although semi-structured, the interviews aimed to address several key themes from the preceding review, including: knowledge of regional skills provision; relationships between industry and skills training providers; responsiveness of skill provision; succession planning; and continuing professional development. Additionally, there were contextual discussions regarding business or provider experiences, plans, and requirements. The following subsection succinctly presents the core findings from these interviews.

4.2 Findings

Human capital and expertise were widely acknowledged by respondents as crucial factors for business operations, firm productivity, cluster development, and the wider semiconductor industry's growth. Interviewees, including representatives of multinational enterprises within the cluster, emphasised the importance of people and skills in the successful expansion and resilience of the cluster and securing continued foreign direct investment. They were clear that the existence of an appropriately skilled workforce was a critical factor in parent company decisions to invest within the region. Several cluster firms have been taken over on multiple occasions, and successive investors have always been particularly interested in people.

Talent pipeline

Despite these cluster advantages, several skills and talent pipeline concerns were raised by respondents. A central theme discussed by interviewees was the workforce demographics and age of semiconductor industry employees, particularly within the cluster. The relative age and anticipated rate of retirees varied from firm to firm. Although some cluster firms have long-standing workforces close to retirement age, others have reported the average age of their employees had decreased in recent years. Nevertheless, the future talent pipeline remained a major concern for many respondents, prompting them to engage in various initiatives to promote the industry as a career choice for the next generation. There are a range of semiconductor skills initiatives that have been developed, and Table 4 below identifies some of the core areas of activity.

Table 4.1: Semiconductor skills initiatives in Wales

Initiatives Summary
ESPRC Centre for Doctoral Training in Compound Semiconductor Manufacturing (led by Cardiff University in partnership with the University of Manchester, University of Sheffield, and University College London)
Dedicated MSc degrees in Semiconductor Technology and Applications at Swansea University and Cardiff University
Semiconductor Skills Academy at the Compound Semiconductor Applications Catapult (in collaboration with UKESF, CSconnected and its member companies, Innovate UK, Driving the Electric Revolution and the Gatsby Foundation)
Dedicated Semiconductor Skills qualifications accredited by the Welsh Joint Examination Committee (WJEC) for level 2-4 (Introduction to Advanced Manufacturing Technologies, Semiconductors; Higher technical Qualification for semiconductor technicians)
Centre for Professional Development at Cardiff University (UKRI Strength in Places funded)

Outreach initiatives offered by individual firms, other cluster partners, or coordinated by the cluster organisation were widely regarded as positive. Cluster firms actively participated in appropriate careers fairs and regularly engaged directly with local schools. Firms also aim to coordinate such activity, with different firms taking the lead in difference local authority areas and seeking ensuring a socio-economically diverse range of communities are engaged. During these activities, firms highlight semiconductors as a critical technology, helping to raise awareness and introducing the industry as a positive future career choice. Additionally, firms offered structured work placements for students at school age and higher education students studying relevant qualifications (for example: material science, physics, chemistry, and engineering). Such opportunities, it was felt, offered not only opportunities to promote the industry as a career choice, but also, particularly for HE students, early practical opportunities to gain some initial 'on-the-job' type experience, possibly leading to future post-study employment offers.

Despite the active outreach programme, respondents generally felt that the visibility of the semiconductor industry, particularly as a career choice, was low compared to other opportunities requiring similar skillsets. This was partly due to the lack of semiconductor-related content in curriculums, which extended from GCSE and FE to HE levels, although some respondents pointed to the recent development of an MSc degree in semiconductors. Despite these perceived curriculum weaknesses, interviewees suggested that there was a good supply of graduates with core skills. This was attributed to the geographical proximity of a range of universities to the cluster, although these graduates often lacked practical experience gained on-the-job.

Pedagogical instruments

Interviewees raised several concerns about the appropriate pedagogical instruments used to train existing, new, and future industry employees. Cluster firms, particularly those with larger regional operations and ties to multinational enterprises, often provided their own internal training programmes for both new and existing employees. In some cases, this was supported by regional private sector training companies or machine and equipment suppliers. Relationships with regional further education colleges varied from firm to firm, with a general preference for internal company arrangements to 'skill up' recruits. Some cluster partners suggested that more could be done to engage with externally provided initial training for new starters before they became too integrated into business operations.

Respondents noted that the education and skills required for new recruits varied significantly from job to job. While entry-level operative posts typically needed 3-4 relevant GCSEs, there were opportunities for upskilling and career progression after recruitment. For employees recruited at A Level, some firms had subsequently sponsored degree programmes. Graduate-level skills demand varied across businesses, with some reporting no shortage of applicants while others with higher demand for graduates found it harder to fill higher-level positions, particularly in certain fields. Overall, while some technical posts were more challenging to recruit than others, recruitment needs could generally be met within a reasonable timeframe.

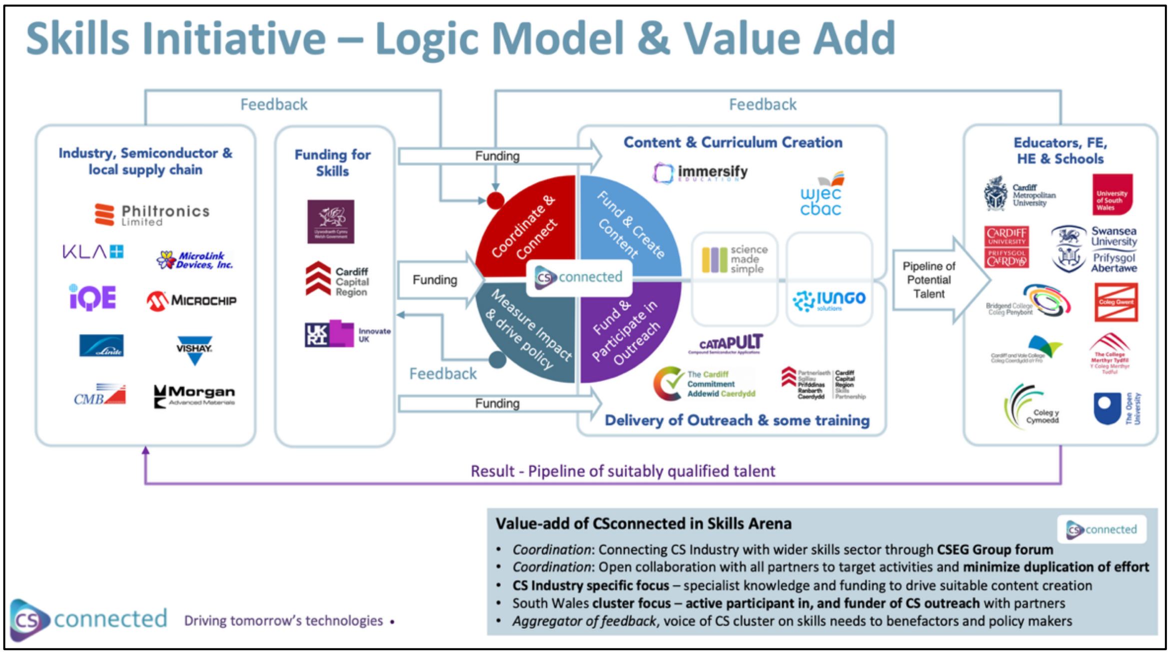
Some interviewees, particularly those responsible for training and education provision, highlighted the difficulties in recruiting suitably qualified lecturers, trainers, and technical staff for programmes or to operate and maintain lab equipment. This was linked to the generally low uptake of STEM subjects, but compounded by the lack of an appealing career pathway for these professionals within the education sector, compared to opportunities in the semiconductor industry for which they were also well qualified.

Apprenticeships were generally seen as particularly helpful, but, it was noted by some respondents, there were too few apprenticeship opportunities available within the cluster. While Wales was suggested to manage apprenticeships more successfully than elsewhere, the long-term comments firms needed to make about taking on apprenticeships meant that numbers were generally low, including level 3 apprenticeships. Despite the varying number of apprenticeship opportunities across firms and the low numbers remaining by historical industry standards, the interest in apprenticeships was widespread and genuine among respondents. Some firms have discussed and considered shared apprenticeships, but had concluded that these may not be suitable for their current business needs. Consequently, some respondents felt there was a need for greater public-private partnership to overcome the challenges in this area and to help drive forward a significant increase in apprenticeship provision

Understanding skills training

Respondents generally agreed that cluster firms had a good understanding of the skills training options available. However, their engagement in this area tended to be cyclical, influenced by whether firms were contracting or expanding their cluster operations. Several interviewees highlighted the CSconnected Compound Semiconductor Skills and Education Group (CSEG), which, since 2018, has occupied a core role as an information conduit and coordinating mechanism. Figure 1 illustrates CSconnected's core coordinating position in this space. Other cluster firm respondents were also keen to point to the existence of a cluster HR director network that helps coordinate activity alongside of the CSconnected mechanism.

Figure 4.1: CSconnected Skills Arena



Source: CSconnected

In furthering its coordinating role, CSconnected's current skills plan encompasses three core pillars of activity, including:

- Securing talent pipelines by inspiring the next generation towards pursuing STEM subjects and careers in semiconductors.
- Helping to support further education students into semiconductor relevant qualifications, particularly through vocational qualifications through apprenticeships at levels 3-5.
- Supporting the upskilling of existing workforces through CPD opportunities, promoting career progression, and fostering inclusivity.

These priorities and associated activities have been developed through the mechanism of its education group, encompassing representatives of industry, education bodies, and wider cluster partners.

4.3 Centre for Professional Development

Respondents generally felt that the CPD courses led by Cardiff University received positive feedback from participants. These courses, summarised in the table below, have been pitched at an introductory level, predominantly aimed at new or prospective industry recruits. Interviewees also acknowledged, however, that whereas such courses have been generally well received, grant funding conditions may have prevented the development of more specific course content. Grant conditions, it was highlighted, prevented course content from being tailored to meet the needs of specific firms, potentially leading to lower-than-expected take-up of some CPD courses by cluster partners.

Table 4.2: Cardiff University CPD Courses (since 2019)

Course
Cleanroom protocols (introduction to the cleanroom environment and its working practices)
Introduction to compound semiconductor photonics
Introduction to compound semiconductor electronics part 1 (online)/part 2 (in-person)
Introduction to wire bonding
Introduction to etching for semiconductor manufacturing
Fast-track integration programme for engineers (planned, 2026)

One challenge to the delivery of these CPD courses for current industry employees, highlighted by some respondents, is the difficulty firms face in making staff available during work hours and the resulting disruption to business operations. Consequently, some staff are required to undertake non-essential training outside of work hours. However, there was a suggestion from some respondents that arrangements to cascade knowledge from specific courses within companies could be further developed, even when staff are willing to study in their own time. While several interviewees emphasised the need for greater flexibility in grant arrangements to broaden skills provision opportunities across South Wales—not just limited to residents and employees in South East Wales—they also recognised the importance of providing support to firms in addressing these challenges.

5. Conclusions and recommendations

5.1 Conclusions

This case study has explored the critical role of skills and talent in the semiconductor industry, with a particular focus on the compound semiconductor cluster in Wales. It has highlighted the symbiotic relationship between skills supply and demand, emphasizing that an adequate supply of local skills is crucial for investment and growth in advanced manufacturing industries like semiconductors. The semiconductor industry's need for constant innovation makes it highly dependent on a qualified workforce, and shortages in appropriate skills can impede the movement of firms into new locations, the productivity of firms, and the sustainability and growth of existing clusters.

The case study has investigated the skills and talent pipeline supply and demand factors likely to influence the future development of the global semiconductor industry, as well as specific regional issues that may impact the future growth of the compound semiconductor cluster in Wales. It has also considered how far productivity growth might be supported within the UK semiconductor industry, and Welsh cluster, by skills development initiatives, and how skills development programmes might also help facilitate increased networking and sharing of best practice.

Overall, the case study has identified that the major global shortage of STEM students and graduates, which is a significant concern for the industry's future, is shared within the Welsh context. Whereas the cluster is largely able to recruit sufficient talent to meet its current needs, the further sustainability and growth of the cluster will require greater investment and uptake of relevant subjects and disciplines, and the subsequent ability to attract more younger people from diverse backgrounds to pursue careers in the industry.

Although the case study has found clear efforts to coordinate skills provision and other talent pipeline activities, continued and greater efforts are likely to be required to meet anticipated industry demand. Nevertheless, the recent investment in Wales via the CSconnected £1m Supply Chain Development Programme pilot, which is seeking to create, expand, and promote innovation in the regional supply chains, has recognised a latent regional skill base opportunity and is an important development.

5.2 Recommendations

This case study offers a series of recommendations to help address the critical issues identified in the proceeding discussion. Although there has been significant progress in recent years related to enhancing skills and supporting talent pipelines within the cluster and by its respective partner organisations, including within areas highlighted by the following recommendations, there are invariably opportunities to continue to enhance and expand existing activities. The following recommendations are indicative of the broad areas of activity necessary.

1. **Invest in STEM Education**

   Increasing the uptake of STEM subjects at all levels of education, and by a greater diversity of students, is essential for building a robust talent pipeline. This can be supported through expanding scholarships, targeted education campaigns, and hands-on learning experiences. Encouraging diversity in STEM fields, including greater participation from underrepresented groups and those from socio-economically disadvantaged communities, can also help expand the pool of potential talent.

2. **Develop Apprenticeship Programs**

   Apprenticeships provide a valuable pathway for developing workforce competence and enabling specialist vocational routes. Expanding apprenticeship opportunities, including degree apprenticeships, can help address skills shortages in technical roles. Collaborative efforts between firms to offer shared apprenticeships can also be explored to meet business needs. Although there are industry efforts to offer apprenticeships, there is significant scope to expand these opportunities within the cluster, but this may require greater support and investment from cluster partners to bring forward. It will also require a longer-term training commitment from cluster firms.

3. **Promote Industry-Specific Training Programs**

   Developing specialised training programs that address the unique needs of the semiconductor industry can enhance workforce readiness. This includes modernising curricula at every level to reflect industry demands, offering industry-supported training courses, and providing targeted manufacturing-related training, industry-endorsed bootcamps, and reskilling programs that can assist individuals transition into semiconductor careers. There has been progress in these areas in recent years, but there is scope to further expand this activity.

4. **Increase Visibility of Semiconductor Careers**

   Raising awareness of the semiconductor industry as a viable and attractive career choice is crucial. This can be achieved through targeted outreach programs in schools and universities, industry-sponsored career fairs, and public awareness campaigns. Highlighting the importance and impact of semiconductor technology can help attract more students to pursue relevant STEM subjects. There have been notable efforts by the cluster as a whole and individual firms to support these activities, but continuing to develop these activities further is an essential task for the cluster moving forward.

5. **Support Ongoing Professional Development**

   Continuous professional development (CPD) programs are vital for keeping the existing workforce updated with the latest technological advancements. Offering CPD courses tailored to the specific needs of semiconductor firms can enhance employee skills and productivity. More flexible grant arrangements, and support for firms to manage staff training during work hours, can improve the uptake and direct relevance of CPD opportunities.

6. **Facilitate International Talent Recruitment**

Given the global competition for semiconductor talent, immigration policies should support the recruitment and retention of international skills where appropriate. Streamlining visa processes and offering incentives for international graduates to stay and work in the UK can help mitigate talent shortages. Additionally, fostering an inclusive work environment that values diverse perspectives can not only help attract talent from around the world, but also help attract domestic talent to the industry and improve productivity.

7. **Enhance Coordination Between Education Providers and Industry**

Establishing stronger partnerships between universities, further education colleges, and semiconductor firms can ensure that educational programs align with industry needs. This includes developing curricula that incorporate practical, hands-on experience and industry-specific knowledge. Collaborative initiatives such as internships, apprenticeships, and industry-sponsored research projects can bridge the gap between academic learning and real-world applications. The cluster has provided a significant platform for this activity, and it is critical this work continues to be enhanced and supported.

8. **Strengthen Regional Skills Ecosystems**

Building integrated frameworks for regional skills policy can support improved productivity, innovation, and competitiveness. Further connecting stakeholders involved in regional skills ecosystems with those defining regional development strategies can foster smart specialisation and regional industrial branching. Local mediating partnerships between employers and regional training providers, such as that provided by CSconnected, play a crucial role in addressing skills shortages. This forum should be further enhanced to provide a truly representative forum for industry and education and skills providers to coordinate activity.

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Cardiff Business School
Ysgol Busnes Caerdydd

Welsh Economy Research Unit
Cardiff Business School
Cardiff University,
Aberconway Building,
Colum Drive,
Cardiff CF10 3EU