CSconnected response to call for evidence

The Semiconductor Industry in the UK

1. CSconnected represents the voice of the UK's compound semiconductor cluster centered in and around South Wales.

2. This written submission is in response to a call for evidence in support of an inquiry into the strengths and weaknesses of the semiconductor industry and its supply chain in the UK.

3. Semiconductor supply chains are complex, fragmented and global in nature. The industry sector tends to cluster around anchor organisations such as Silicon Valley in California. Despite having strong roots in the USA there has in the last two decades been a migration of the technologies to Asia where the likes of Taiwan and Korea dominate global markets for microprocessor and memory chips for computers.

4. The UK has a rich history in semiconductor technologies and remains strong in three specific areas of this multi-faceted industry sector: chip architecture design; compound semiconductors; and specialist equipment manufacturing. Although each of these three areas play a critical role in semiconductor supply chains, they each have their own unique characteristics and needs.

5. South Wales is home to the World's first compound semiconductor cluster and CSconnected provides the response on behalf of cluster partners operating across all Technology Readiness Levels (TRLs) from research, development, and innovation to globally recognised volume manufacturing.

6. A brief summary of responses to the call for evidence is shown below with fully detailed responses in the pages that follow:

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

7. The global nature of semiconductor supply chains makes it impossible to disaggregate the UK from the rest of the world.

8. Semiconductor markets are dominated by silicon which has evolved over the last 50 years through continuous miniaturization enabling the integration of components on a single chip to grow from around two thousand in the 1970s to more than thirty billion in todays advanced processor chips.

9. The miniaturization that has led to enormous increases in computing power has seen escalation costs in production facilities that in turn has led to fierce global competition and industry dominance by a handful of major players.

10. With an annual value of $500B the semiconductor sector is the world's fourth largest industry behind oil production, automotive and oil refining & distribution. The industry is forecast to grow to $1T by 2030.

11. New and emerging technologies in connectivity, healthcare technologies, electrification, automation, AI and quantum technologies will drive demand for semiconductors over the coming decades.

12. These new and emerging technologies will depend on the unique properties of compound semiconductors that complement silicon processors. The compound semiconductor industry currently represents around 10-12% of the total semiconductor market and is growing.

What is the UK's semiconductor supply chain and is this secure? If not, how can this be improved? What specific strengths does the UK have to contribute to regional or global semiconductor supply chains? How competitive is the UK within the global context of the semiconductor industry?

13. There are multiple semiconductor supply chains serving a wide range of technology applications and end markets. Most developed nations recognize the importance of securing and maintaining sovereign capability in this key technology but the race for control and dominance inevitable renders some capabilities as vulnerable to merger and acquisition activity.

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

14. The UK dominates the industry in chip architecture design but re-entry to high-end microchip manufacture would be a major challenge and extremely expensive for the UK. It is important to maintain the UK's position in chip design.

15. Areas such as compound semiconductors where the UK has a leading global role is an area that will be key to connectivity, sensing, energy (net-zero) and quantum over the next few decades and represents a high return on a more modest investment than most silicon based technologies.

In which industries does the UK not have an end-to-end semiconductor supply chain? Are there any opportunities for these supply chain gaps to be filled within the UK?

16. Other than chip architecture design, the UK does not have strong end-to-end supply chains and the cost and time-frames involved in establishing such supply chains is extremely high and there would be significant challenges.

17. Establishing and maintaining supply chains in other essential semiconductor activities such as compound semiconductors is an achievable aspiration, particularly where high levels of IP, know-how and expertise already exist.

How can the Government strengthen semiconductor research and innovation? Are there any current areas of weakness in the present Government strategy to semiconductor innovation? Is there effective communication between the various stakeholders within the UK's semiconductor ecosystem?

18. The "low hanging fruit" that could quickly help to improve cohesion include:

19. Increased community cohesion through the formation of an industry led Semiconductor Leadership Group and a National Network of Academic Excellence;

20. Increased support for semiconductor science across EPSRC portfolio eg: renewed focus on cross-cutting themes, World Class Labs and increased support for National Research Facilities with semiconductor relevance;

21. Deployment of additional support for Manufacturing Hubs, and a dedicated Low -TRL 'Advanced Semiconductor Research Fund'; and

22. Delivery of a new 'Assured Supply Chain Innovation Programme' to address critical applications and sovereign capability of UK priority areas.

Does the UK have the required skills, talent and diversity to be able to boost its current semiconductor industry and to respond to future disruption?

23. Support is needed to further develop and roll out a UK-wide comprehensive framework from school leaver to post-graduate and late-career candidates, such as a National Semiconductor Skills Academy (NSSA) focused on Continuing Professional Development (CPD) and cross training of staff from other manufacturing sectors.

24. In addition, there is a need for a comprehensive UK-wide approach to outreach is required to prime a future talent pipeline that aligns with the needs of the semiconductor industry growth.

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

25. There are numerous national security concerns and vulnerabilities within the current UK Semiconductor supply chain, ranging from minimal UK control over most of the large-scale manufacturing of semiconductor chips within the UK, to the forced outsourcing of our most sensitive Defence related chip designs to overseas manufacturers, posing a real and present threat to the UK's national security.

26. This is discussed in more detail in the pages that follow.

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

27. The UK lags other major nations in determining its overall semiconductor strategy. Major investments are being pledged by countries around the world to build powerful sovereign capabilities for semiconductor chip manufacture. For many nations, the reshoring of semiconductor manufacturing is an acknowledgement that downstream industries are dependent on fragmented and uncertain semiconductor chip supply chains and that reliance on other countries creates vulnerabilities in terms of national economic, military or technological security.

28. A clear, coordinated UK policy and strategy sends a strong message and provides certainty both to the home based industry sector and to the international community.

CSconnected detailed response to call for evidence

The Semiconductor Industry in the UK

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

30. Semiconductor devices are ubiquitous and are found in every aspect of our daily lives from enabling applications including global communications, sensing, healthcare technologies, electric and autonomous vehicles and in driving energy efficiency.

31. It should be considered that like most industry sectors, there are multiple semiconductor supply chains spanning many different technologies and end market applications. Our particular interest (and the UK's key semiconductor supply chain strength) is in compound semiconductors based on materials such as Gallium Arsenide (GaAs), Indium Phosphide (InP), Gallium Nitride (GaN) and Silicon Carbide (SiC) to name a few. Compound semiconductors complement silicon-based technologies by providing higher performance capabilities and advanced photonics properties. It should be noted that these materials are all specifically included under the Advanced Materials section of the NSIA areas of national security concern to the UK.

32. The range of applications enabled by compound semiconductors is set to grow significantly as new technologies are developed to take advantage of the superior material properties of compound semiconductors, in areas such as enhanced communications (6G and beyond), electrification of transport (Electric vehicles and charging infrastructure), data storage, robotics, AI, machine vision, augmented reality, advanced gaming, net-zero energy applications (sustainable energy and mobility), defence and aerospace, satellite technologies, healthcare technologies and wearable diagnostic devices.

33. The complex global nature of semiconductor supply chains means that it is not possible to separate national demands from global demands. The current the scale of the compound semiconductor materials and devices market range from $50-90B in the context of an overall semiconductor market of around $450B across all sectors that is predicted to grow to $1T by 2030. The global semiconductor industry is the fourth largest behind oil production, automotive and oil refining and distribution. The markets and applications for compound semiconductor devices are diverse, and the global compound semiconductor market is growing at almost twice the rate of the long-established silicon semiconductor market. For example, the fastest growing opportunities in the compound semiconductor global markets are:

34. The SiC power device market is expected to explode from $1B to $6B between 2021 and 2027 driven primarily by adoption in electric vehicle technology and fast charging infrastructure.

35. The GaN RF market is expected to grow from $740M to >$2B between 2020 and 2025 driven by military applications and 5G telecom infrastructure.

36. The GaN microLED display market is expected to grow from $500M to > $7B by 2025 driven by emergent technologies such as head-up displays and displacement of LCDs and OLEDs in large area displays.

37. The GaAs Vertical Cavity Laser market is expected to grow from $1B to >$2.7B between 2020 and 2025 primarily driven by smartphone facial recognition, LiDAR and optical telecommunications applications.

38. The InP laser chip market is expected to grow from $2.1B to $5.1B between 2020 and 2025, driven by a wide range of optical communications and sensing applications.

What is the UK's semiconductor supply chain and is this secure? If not, how can this be improved? What specific strengths does the UK have to contribute to regional or global semiconductor supply chains? How competitive is the UK within the global context of the semiconductor industry?

39. The UK has very few coherent and secure overall semiconductor supply chains, but is home to significant players who contribute to the overall global supply chains for semiconductors.

40. It should be emphasised that the semiconductor sector comprises multiple technologies spanning multiple, fragmented, global supply chains. Some more traditional semiconductor supply chains are fully **vertically integrated**, where the design, materials, device, components and sub-systems manufacture are carried out by a single vendor. Such examples include the likes of Intel, Samsung and ST. However, as with most mature

industry sectors, the trend today is towards segmentation into **open access foundry business models** where chip design IP, wafer manufacture, chip manufacture, packaging and subsystem assembly are carried out by different specialised entities such as ARM (design), SOITEC (wafer manufacture), TSMC (chip manufacture) and Microchip (packaging). This is the typical supply chain in CMOS micro-processors. There is a wide and complex spectrum of variation in the model across different types of semiconductor components: Digital, Analogue, Memory, Photonic, Power, Radio Frequency (RF), Quantum, etc.

41. The largest global concern at the moment is the concentration of Silicon CMOS open access foundry in Asia (75% of global IC manufacturing output), particularly in Taiwan via companies such as TSMC and UMC. Whilst this is the primary geo-political concern because of Sino/Taiwan tensions, there is a huge complexity in manufacturing models across the semiconductor sector, which are less visible, but as strategically important, as the Silicon foundry concentration.

42. The UK has several globally relevant strands of activity:

43. Fabless design IP for micro-processers: a historical strength that has produced companies such as ARM, Imagination and Graphcore. However, as noted above this is only a small part of the overall supply chain and almost all manufacture of the UK chips designs are made in Asia, by open access foundries such as TSMC.

44. Compound Semiconductor technology and manufacturing: a world leading cluster in South Wales is the UK's most complete supply chain, which supports a workforce of ~2400 that is rapidly expanding, but there are also sub-clusters of research and manufacturing in specific geographies across the UK, ensuring there are nationwide supply chain opportunities.

45. A wide research base in next generation compound semiconductor and other advanced technologies including Silicon Photonics, organic semiconductors, flexible semiconductors, photovoltaics and semiconductor devices for Quantum systems.

46. An extensive equipment supplier base ranging from wafer manufacturing capital equipment, metrology, specialty materials used in semiconductor manufacturing, and services which contribute strongly to supporting manufacturing supply chains outside the UK.

47. Whereas chip design on its own only delivers a small fraction of the value chain (typically 2-3%), full manufacturing of wafers, chips and packaging delivers greater than 80% of the value chain and creates up to 10 times the number of jobs. It follows therefore that in developing a strategy that creates serious value for the UK economy, we must focus on expanding our global relevance beyond chip design to full scale manufacturing of advanced, high value (eg compound) semiconductor devices.

48. It would take a huge investment (£10's Billions) with significant risk for the UK to become even remotely globally relevant in leading edge silicon chip manufacture (at 3nm-22nm technology nodes). However, the UK is globally recognised as a leading player in the newer and more powerful compound semiconductor technologies, particularly with the establishment and development of the world's first Compound Semiconductor Cluster "CSconnected' located in South Wales, which has built on several decades of world leading R&D within the UK academic and industrial base.

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

49. The South Wales Semiconductor Cluster is a prime example of how regional-scale co-ordination can rapidly create globally relevant critical mass to pump prime a virtuous circle of expansion of economic activity. The ecosystem is based on interdependency and common goals, and a coordinated manufacturing base in 70-mile corridor from Chepstow to Swansea. Over the last 6 years, intense government, academic and private sector collaboration has built on indigenous capability and assets in South Wales, driven by a collective vision first published in 2015.

50. In 2021 the ecosystem grew by 14% to 2,390 staff involved in research, engineering and high value add manufacturing, with in excess of 20% of the workforce engaged in R&D and innovation intensive activity. Collective turnover of industry partners is in excess of £500M, and over 95% of manufacturing output is classed as export (mostly outside of the EU), representing 2.5% of total Welsh export. The Cluster directly

contributes £174M pa to UK GVA (gross value-add), but this grows to £248M pa once supply chain and household effects are considered. Each direct job in the cluster supports an additional 0.51 jobs elsewhere in the Welsh economy and over £121,000 of GVA per employee. The sector is characterised by high productivity, higher than average wages, and GVA per job well in excess (>2x) of the Welsh average.

51. The Cluster output is export led, high value-added manufacturing underpinned by an RD&I intensive workforce, which is showing a persistent expansion in output, productivity, job creation and GVA contribution to the Welsh economy. It has a clear vision which is delivering a significant increase in RD&I and manufacturing capacity within an overall private and public investment commitment in excess of £700M since 2015, of which we estimate £350M has been executed to date.
52. To take advantage of the expanding opportunity for advanced semiconductor components, the Cluster aim is to more than double the workforce to more than 4,700 and to grow GVA to more than £380M per annum beyond 2025, via both accelerated organic growth and inward investment, as the demand for high-end advanced compound semiconductor products rapidly expands in a global annual market worth around $50B.
53. Recent investments are focused on further increasing co-ordination, collaboration and collective gainshare in the Cluster over the next 5-10 years. This activity gives the UK a strategic proposition and response to global expansion in semiconductor demand, with the following **strengths**:
54. A high-value USP in a rapidly expanding sub-sector of the semiconductor industry.
55. A high degree of co-ordination at regional level, with clear long-term objectives.
56. A high RD&I intensity which mirrors the global semiconductor industry.
57. An inherent focus on the levelling up agenda.
58. A clear understanding of UK strategic priorities, with a global ambition.

59. However, the Cluster is in an early stage of development, hence there are specific **structural weaknesses** associated with rapid growth with a global context of a booming demand for semiconductor skills, intellectual property and manufacturing capacity:

60. Demand pressure and post-BREXIT repatriation has caused a shortage in skilled labour, which is starting to fuel wage inflation in the sector.
61. Intense merger and acquisition activity over the last 4 years has disrupted the keystone ambition of delivering an 'at-scale' open access manufacturing supply chain across the region.
62. Public investment in infrastructure projects has proceeded at a rate which is incompatible with the rapid cyclical expansion patterns that are common in the semiconductor industry.
63. The lack of a UK national policy in semiconductor technology undermines the credibility of the activity as a priority sector for FDI and economic action.

Opportunities for strengthening the UK and regional ecosystem

64. We have consulted with partners across the CSconnected cluster and have explored six areas where targeted action will ensure the resilience of the existing UK activity, accelerate expansion, and improve the potential of the return on the investment in semiconductor technology in the science base:
65. Governance: Increase co-ordination and community cohesion:
66. between UK Government departments: formation of the 'Office for Semiconductors'.
67. formation of Semiconductor Leadership Group (Industry) and National network of excellence (Academia).
68. Facilitate manufacturing scale up:
69. Create an integrated Capital Fund to leverage inward investment and indigenous expansion via structured co-ordination between British Business Bank / Venture Capital / Regional Shared Prosperity Fund priorities.
70. Alignment with European projects of scale in semiconductor supply chains eg Important Projects of Common European Interest and a semiconductor focused UK-EU Trade and Cooperation Agreement (TCA).

71. Facilitate commercialisation of IP generated by RD+I activity:
72. Create ‘Semiconductor Innovation Zones’ aligned with the SMART specialisation priorities of UK regions to increase the focus on supply chain co-operation.
73. Create an ‘Open Access’ device foundry infrastructure focused on advanced semiconductor innovation.
74. Promote opportunities for Government procurement such as Small Business Research Initiatives, GovTech Catalyst in semiconductor technologies.
75. Foster more high-quality RD+I:
76. High TRL: Create a ‘Assured Supply Chain Innovation Programme’: addressing critical applications and sovereign capability of UK priority.
77. Mid TRL: Offer additional, low term support for Manufacturing Hubs and Catapults, with a dedicated ‘Advanced Semiconductor Research Fund’.
78. Low TRL: Increase support across EPSRC portfolio eg: renewed focus on cross-cutting themes, World Class Labs and increased support for National Research Facilities with semiconductor relevance.
79. Skills
80. Development and delivery of comprehensive education packages from school leaver to post-graduate activities
81. To support outreach activities to promote opportunities for education and careers.
82. Promote export
83. Designate semiconductor technology a ‘National High Potential Opportunity’, with coordinated action from DIT on regional specialties.

An expansion of the detail of the actions is given in Appendix 1

In which industries does the UK not have an end-to-end semiconductor supply chain? Are there any opportunities for these supply chain gaps to be filled within the UK?

84. The UK currently does NOT have any full functional end-to-end semiconductor supply chains (at scale) in any of the major industrial sectors. However, considerable work is underway to build these complete end-to-end sovereign semiconductor supply chains in several areas, as noted below;
85. Electric Vehicles and fast charging infrastructure.
86. Quantum Technologies
87. Defence applications
88. Wearable healthcare diagnostics at clinical grade accuracy
89. Satellite power supply
90. Communications

How can the Government strengthen semiconductor research and innovation? Are there any current areas of weakness in the present Government strategy to semiconductor innovation? Is there effective communication between the various stakeholders within the UK’s semiconductor ecosystem?

91. Currently the UK supports low-TRL semiconductor R+D in multiple places across the UKRI portfolio, but there is little collective goal setting or semiconductor challenge-pull to bring UK wide co-ordination or focus to the research. Whilst this leads to a lot of high-quality activity, (we estimate there are in excess of 25 Universities in the UK with active semiconductor/application activities), a bottom-up excellence-led approach has some inherent weaknesses:
92. Replication of capital equipment and infrastructure across multiple institutions.
93. Lack of coherent outcomes across the semiconductor supply chain (design/materials/device/components/subsystems), where different aspects may be at different TRL levels.

94. Retention of expertise – sub-critical mass research activities lead to short-term projects which struggle to retain expertise and progress key elements of IP.

95. Often low-TRL R+D is carried out in the absence of ‘pathways to scale-up’ and in isolation to manufacturing expertise. Given the cost of commercialisation and scale-up is many times the cost of invention in semiconductor technology, it is hard to see how ‘siloed’ R+D activity can produce a return on the public investment in the science.

96. We feel there are obvious opportunities to improve cohesion, increase the focus and potential for exploitation:

97. Increase community cohesion: formation of an industry led Semiconductor Leadership Group and a National Network of Academic Excellence. This should aim to support existing excellence in the research base, and strive to improve the connection between semiconductor physics, materials science and devices with advanced systems and new applications.

98. Increase support for semiconductor science across EPSRC portfolio eg: renewed focus on cross-cutting themes, **World Class Labs** and increased support for **National Research Facilities** with semiconductor relevance.

99. Deploy additional support for **Manufacturing Hubs**, and a dedicated Low -TRL ‘Advanced Semiconductor Research Fund’. Promote **semiconductor manufacturing research** and **‘design for scale-up’** to increase the potential and probability of delivering a commercial impact of the science investment.

100. Deliver a new ‘Assured Supply Chain Innovation Programme’ to address critical applications and sovereign capability of UK priority which **recognise the complexity in sub-system and system supply chains**, and offer targeted investment to address innovation across extended semiconductor supply chains aligned with the pillars in UK Innovation strategy and long-term sovereign capability need.

101. There are also multiple opportunities to improve the commercialisation success rate and value potential of higher TRL UK semiconductor innovation, whilst at the same time promoting a fertile environment for Foreign Direct Investment (FDI) to bolster our indigenous ecosystems:

102. Creation of Semiconductor Innovation Zones: Targeted incentives to encourage start-ups and FDI aligned with appropriate existing regional strengths in semiconductor technology: eg. Wales: Advanced semiconductor manufacturing, Scotland: Photonic applications, NI: Magneto-optical storage, North East: RF systems, South West: Digital, Quantum and Cybersecurity etc.

103. Increased opportunities for Government procurement: For example, ‘Semi-Small Business Research Initiatives’, and GovTech Catalysts to create opportunities for semiconductor technology innovation and agility to solve pressing issues across MoD and the Security services, NHS, National Grid and energy industry, future resilience in communications, aerospace, transport and smart cities.

104. Increased ‘Open Access’ facilities focused on advanced semiconductor innovation to increase the UK’s ability to negotiate the ‘valley of death’ in semiconductor innovation by creating a structured pathway from University facilities to Industrial scale-up to increase the potential of economic impact from the UK investment in the semiconductor science and engineering base.

Does the UK have the required skills, talent and diversity to be able to boost its current semiconductor industry and to respond to future disruption?

105. There is currently no visible, coordinated focus on semiconductor skills as a priority within the UK wider skills agenda, but there are isolated activities which align with specific regional demands or specific academic institutional strengths.

106. For example, the South Wales Cluster partners have formed a Compound Semiconductor Education Group that has representatives from industry, academia (FE, HE) and government organisations. The group has been instrumental in developing and coordinating a number of activities from BTEC/Level 5 curriculum content to apprenticeship frameworks.

107. In addition, the Cluster action has led to specific new semiconductor MSc modules at Cardiff and Swansea Universities and a Centre for Doctoral Training in Compound Semiconductor Manufacturing led by Cardiff University linked to Manchester University, Sheffield University and UCL (2018-2025).

108. Looking forward, a core activity in 'CSconnected', a £43M (2020-2025) initiative to expand the Cluster that is part funded (£23M) by the UKRI Strength in Places Fund, is the development and execution of a plan to upskill 1000 semiconductor employees by 2025, including reskilling those joining the semiconductor community from other industry sectors such as automotive, aerospace and foundational industries in South Wales.

109. The long-term skills and talent vision is aligned to service the expansion of economic activity in the region, underpinned by offering inclusive educational opportunities for school leavers through to PhD level, to unlock latent talent in unrepresented communities.

110. The Cluster Education group is also working with other UK-wide initiatives such as those being developed by the NMI to ensure a consistent approach and sharing of best practice.

111. Our current view is that further support is needed to further develop and roll out a UK-wide comprehensive framework from school leaver to post-graduate and late-career candidates, such as a National Semiconductor Skills Academy (NSSA) focused on Continuing Professional Development (CPD) and cross training of staff from other manufacturing sectors.

112. In addition, we believe a comprehensive UK-wide approach to outreach is required to prime a future talent pipeline that aligns with the needs of the semiconductor industry growth.

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

113. There are numerous national security concerns and vulnerabilities within the current UK Semiconductor supply chain, ranging from minimal UK control over most of the large-scale manufacturing of semiconductor chips within the UK, to the forced outsourcing of our most sensitive Defence related chip designs to overseas manufacturers, posing a real and present threat to the UK's national security.

114. Large scale Silicon chip manufacturing in the UK is dominated by three chip fabrication facilities (fabs); (i) Former IBM fab in Greenock, now owned by Diodes Inc (US) (ii) Nexperia Manchester, formerly NXP Hazelgrove, now owned by Wingtech (China) (ii) Nexperia Newport (largest), until July 2021 under UK ownership as Newport Wafer Fab (NWF), now owned by Wingtech (China).

   a. Thus, by far the majority of the large-scale Silicon Chip manufacture in the UK is foreign owned. There are also an additional (20 or so) much smaller specialised fabrication plants within the UK, although most of these are also under foreign ownership. A major vulnerability for the UK is the potential future closure of these foreign owned plants, as the UK plants become vulnerable to 'reshoring' of production either because of national requirements or for economic reasons (cheaper production on home soil). The UK semiconductor history is littered with this very same dynamic over the last 3 decades (Motorola, IBM, Raytheon, Fujitsu, Infineon, Hyundai, LG Semicon, to name but a few).

115. Since the acquisition of Newport Wafer Fab by Nexperia in 2021, there is no longer an 'open access' chip fab of any equivalent scale and breadth of capability in the UK. This means that all fabless chip design companies in the UK requiring development and manufacturing scale-up are likely to seek overseas partners. This creates several issues:

116. Sensitive chip design IP is exposed to foreign chip manufacturers, so this route is problematic for supply chains that require sovereign or economic security. The consequence of this situation is profound; critical designs of chips for use in UK military applications are having to be built by foreign owned and controlled fabs. The desirable default is to ensure sensitive designs are manufactured on-shore, through 'trusted' fab partners who have the relevant national security clearance and approvals to be able to build chips for national Defence applications in a secure manner.

117. Reliance on foreign manufacture effectively exports high skilled, high paid jobs to those countries rather than creating them in the UK. This poses huge vulnerabilities to the companies themselves but also a much broader economic vulnerability to the UK economy because of our total reliance on foreign manufacture of UK designed chips. The current drive to 'on shoring' semiconductor chip manufacture by every major nation is for that very reason; to offer a degree of protection of domestic downstream manufacturing industries.

118. There are several other areas listed under the NSIA where future onshore exploitation by UK supply chains would be hugely beneficial, including Quantum Technologies, Artificial Intelligence and Communications. In the case of Quantum Technologies, the UK has committed almost £1 billion to developing the science and technology to world leading status, and now have a fledgling 'Quantum Foundry' initiative, led by the South Wales semiconductor cluster, underway to identify all the key UK supply chain partners required to scale key semiconductor quantum component requirements. However, further investment in open access device foundry is required in order to avoid the situation of a world beating technology created in the UK being commercially exploited beyond the UK shores.

Wider Collaboration

119. The UK should strengthen links and partner with both the US and EU to build strong interdependencies. Whereas the UK lacks the capability to manufacture chips at leading edge nodes, which are being aggressively pursued by both the US and the EU, the UK has real global strengths in advanced chip design, compound semiconductor R&D, wafer technology and design, equipment design and manufacture, quantum technologies, cyber technologies and areas of emergent semiconductor technology such as silicon photonics. Collaboration and alignment with the US on defence and security using UK strengths in exchange for strategic access to leading edge chip supply would seem an equitable arrangement.

120. With regards to collaboration with the EU, the UK has until recently been a close partner. The UK's strength in compound semiconductor technology was recognised via leadership in European instrument used for large scale structural collaboration, namely the Important Projects of Common European Interest (IPCEI). The UK leads the Compound Semiconductor chapter of the 6B euro IPCEI 'Microelectronics for the Future' (2018-2024). However, the UK Government did not to subscribe to this crucial initiative, which is progressing without UK funding support. The EU is now likely to enact IPCEIs as a key action to implement the EU CHIPS act, with commitments of 145 Billion euros. The UK must adopt IPCEI principles and its intervention policies at an absolute minimum, otherwise UK industry will be at a serious disadvantage relative to all other EU nations.

121. Establishing a coherent national semiconductor strategy, building on our strengths, creating vibrant manufacturing ecosystems in advanced semiconductor technologies and establishing end-to-end sovereign supply chains to our most important industrial verticals, would have a very clear major and lasting impact on the UK economy.

122. The global focus on semiconductors provides a unique opportunity for the UK to capitalize on its core innovations for the benefit of the UK economy, by supporting core manufacturing initiatives of advanced semiconductor technologies across multiple industrial supply chains.

123. It is well documented that semiconductor industry jobs not only pay at least 50% higher salaries than the national average, but that for each direct semiconductor job, almost 6 additional jobs are induced in the associated industrial supply chains and wider economy (ref Oxford Economics, SIA study). Furthermore, the level of investment in skills and training means that jobs in the sector are high quality, largely full-time roles with little use of casual or zero-hours employment.

124. The impact on GVA is well over £100k per employee. As an example of the potential UK economic impact, the South Wales compound semiconductor cluster, which already employs 2,400 and directly creates a GVA of £280M per annum, has plans to grow that employment to over 7,000 in the next 10 years. Taking account of the induced jobs multiplier in the wider economy, the resultant total job creation would be over 40,000, leading to a GVA of over £5B per annum. This would be a major contribution to the current Government 's ambition of creating a high skill, high wage UK economy.

125. Other wide-ranging positive ramifications of supporting a strong and coherent sovereign semiconductor sector include a major contribution to reaching net-zero carbon targets with the much higher power conversion efficiencies associated with compound semiconductors, especially related to the electrification of transport (EV and fast charging infrastructure), establishment of a diversified communications infrastructure, self-sufficiency in defence and security chip manufacture, and on shore exploitation of the UKs technology leadership in Quantum technologies, AI, Cyber security, and a host of key new and emerging technologies as previously referenced.

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

126. The UK lags other major nations in determining its overall semiconductor strategy. Major investments are being pledged by countries around the world to build powerful sovereign capabilities for semiconductor chip manufacture. For many nations, the reshoring of semiconductor manufacturing is an acknowledgement that downstream industries are dependent on fragmented and uncertain semiconductor chip supply chains and that reliance on other countries creates vulnerabilities in terms of national economic, military or technological security.

127. A clear, coordinated UK policy and strategy sends a strong message and provides certainty both to the home based industry sector and to the international community.

APPENDIX 1: Specific asks and actions

Area	Action	Aim
Governance	1. Increase co-ordination between UK Government departments: formation of the 'Office for Semiconductors'	Promote cross-government understanding on the existing UK industrial, science and engineering capability in semiconductor technologies, the complexity of global supply chains, the opportunities for UK, and the requirements of a sovereign capability. Consideration of forming an All-Party Parliamentary Group (APPG) to represent the interests of the Semiconductor Industry.
	2. Increase community cohesion: formation of Semiconductor Leadership Group (Industry) and National network of excellence (Academia)	Create a representative forum for the semiconductor community to provide intelligence and independent advice to UK Government.
Scale-up	3. Integrated Capital Fund: British Business Bank / Venture Capital / Regional Shared Prosperity Fund priorities.	Themed investment fund to create a community of informed stakeholders that can take a longer-term view on RoI cases with a more nuanced consideration of supply chain leverage, wider economic and spill-over effects that are inherent with high-value (semiconductor) manufacturing investments.
	4. Alignment with IPCEI and UK-EU Trade and Cooperation Agreement (TCA). State aid implications: adoption of 'first production' as an intervention scheme.	Important Projects of Common European Interest (IPCEIs) are the primary mechanism that the EU will use to increase EU semiconductor manufacturing from 9% to 20% by 2030. UK companies need to be enabled to engage and participate on a level playing field.
Commercialisation	5. Semiconductor Innovation Zones	Create incentives to encourage start-ups and FDI aligned with appropriate existing regional strengths in semiconductor technology: eg. Wales: Advanced semiconductor manufacturing, Scotland: Photonic applications, NI: Magneto-optical storage, North East: RF systems, South West: Digital, Quantum and Cybersecurity etc.

	6. Opportunities for Government procurement: ‘Semi-Small Business Research Initiatives’, GovTech Catalyst	Create opportunities for semiconductor technology innovation and agility to solve pressing issues across MoD and the Security services, NHS, National Grid and energy industry, future resilience in communications, aerospace, transport and smart cities.
	7. Create an ‘Open Access’ device foundry focused on advanced semiconductor innovation: ‘The Advanced Semiconductor Industrialisation Facility’	Increase the UK’s ability to negotiate the ‘valley of death’ in semiconductor innovation. The cost of commercialisation and scale-up can be many times the cost of invention, so there is a need to create a structured pathway from University facilities to Industrial scale-up to increase the potential of economic impact from the UK investment in the semiconductor science and engineering base.
RD&I Capacity	8. Additional support for Manufacturing Hubs, dedicated Low -TRL ‘Advanced Semiconductor Research Fund’.	Recognise the cost of scale up is often many times the cost of invention for new semiconductor devices and sub-systems. Promote semiconductor manufacturing research and increase the potential and probability of delivering a commercial impact of the science investment.
	9. ‘Assured Supply Chain Innovation Programme’: addressing critical applications and sovereign capability of UK priority.	Recognise the complexity in sub-system and system supply chains, and offer targeted investment to address innovation across extended semiconductor supply chains aligned with the pillars in UK Innovation strategy and long-term sovereign capability need.
	10. Increase support across EPSRC portfolio eg.: renewed focus on cross-cutting themes, World Class Labs and increased support for National Research Facilities with semiconductor relevance.	Support existing excellence in the research base, and strive to improve the connection between semiconductor physics, materials science and devices with advanced systems and new applications.
Skills	11. A comprehensive skills framework from school-leaver to postgraduate and late-career.	Create a talent pipeline that aligns with the needs of the semiconductor industry growth. Deliver a National Semiconductor Skills Academy (NSSA) focused on Continuing Professional Development (CPD) and cross training of staff from other manufacturing sectors. Support the delivery of outreach activities to connect school curriculum, HEI, CPD and tertiary.

Export & UK Resilience support	12. Designate semiconductor technology a 'National High Potential Opportunity', with coordinated action from DIT on regional specialties.	Continued focus on the high export potential of semiconductor technology and products. Integrate the UK semiconductor narrative into a 'Global High-tech Britain' brand to support export growth, FDI and global talent acquisition. Establish close links between UK Governance bodies (in sections 1&2) and leading industry bodies across the globe in order to secure partnerships and bilateral supply agreements for areas where the UK has vulnerabilities.