Future State of Machinery Sector

Market Assessment

2025

An AMPI report supported by independent research carried out by SQW

AMPI
THE ADVANCED MACHINERY & PRODUCTIVITY INSTITUTE

SQW

Contents

1. Introduction

1.1 In summer 2021, the Advanced Machinery and Productivity Institute (AMPI) was awarded £22.6 million from Wave Two of UKRI's Strength in Places Fund (SIPF). The project formally began in February 2022 and is due to end in September 2026. It is being led by the National Physical Laboratory (NPL) on behalf of a consortium of academic institutions and private sector organisations from across Greater Manchester and West Yorkshire.

1.2 Partners have an ambition to sustain and scale-up the current SIPF-sponsored activity to benefit advanced machinery manufacturers throughout the UK. The emerging vision is for the enduring Institute to act as a co-ordinating body for a distributed network of capability across the country. In this context, SQW was commissioned by NPL to undertake a market assessment to support the future direction of AMPI.

1.3 The current SIPF programme and longer-term vision are both known by the same AMPI acronym. Unless otherwise stated, the use of AMPI in this report refers to the longer-term Institute, not the current SIPF funded activity.

1.4 This study draws on a desk-based data and document review, three international case studies and consultations with machinery and manufacturing stakeholders.

Report structure

1.5 The remainder of the report is structured as follows:

- **Section 2** provides an overview of the advanced machinery landscape and introduces some of the key drivers of change facing the sector.
- **Section 3** presents statistics on the size of the advanced machinery sector across the UK.
- **Section 4** uses three case studies to offer some insights and learning from elsewhere on advanced machinery focused cluster development.

2. Advanced Machinery and drivers of change

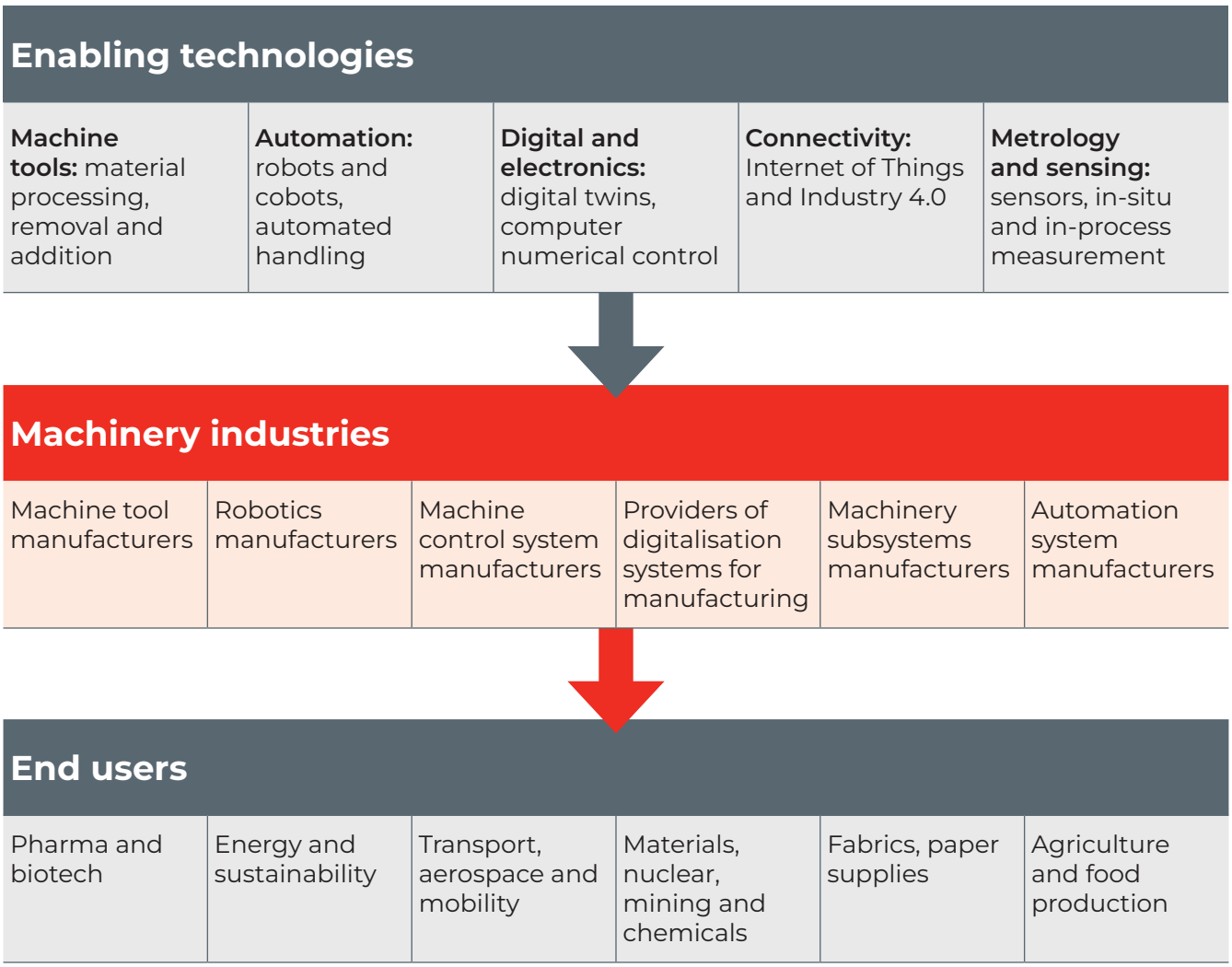
Summary

- Advanced machinery is used across the manufacturing sector – especially where high accuracy is necessary – because of its precision, reliability and efficiency. It includes manufacturers of machine tools, robotics, machinery subsystems and control/digitisation/automation systems.
- The global advanced machinery market is estimated to be worth around $500 billion, with an impressive expected compound annual growth rate of 5-10% over the next ten years.
- A recent report examined the UK's Machinery and Equipment sector (M&E), a sector broader than advanced machinery. This concluded that the UK is a significant M&E exporter, ranked 10th globally.
- However, the UK has an M&E trade deficit. This deficit widened over the 2011 to 2022 period from $2 billion to over $7 billion, driven by a combination of increasing imports and reducing exports. China, Germany and Japan have the largest shares of the global M&E export market.
- The advanced machinery sector depends on demand from the wider manufacturing sector; its sales are often tied to long term investment plans of other companies.
- Key trends in advanced machinery include: offshoring of manufacturing (if not always R&D functions); increased use of digital technologies and AI, e.g. for predictive maintenance; servitisation; robotics integration and customisation; and energy efficiency.

2.1 Advanced machinery refers to technologically advanced equipment and systems used for manufacturing, production, and other complex operations. These machines incorporate innovative technologies to improve efficiency, accuracy, productivity, flexibility, and safety in industrial processes. Advanced machinery is used across the manufacturing sector, especially where high levels of accuracy and precision are required. Its performance advantages over traditional machinery are driven by a range of enabling technologies as shown in the graphic overleaf.

2.2 Companies in the advanced machinery sector include manufacturers of robotics, machine tools, machine control and automation systems. Their customers span the breadth of the manufacturing sector. Manufacturing is an important part of the GB economy, accounting for almost 2.4 million jobs, representing 8% of all employment across GB.[1]

Figure 2-1: Enabling technologies, machinery and end-user industries



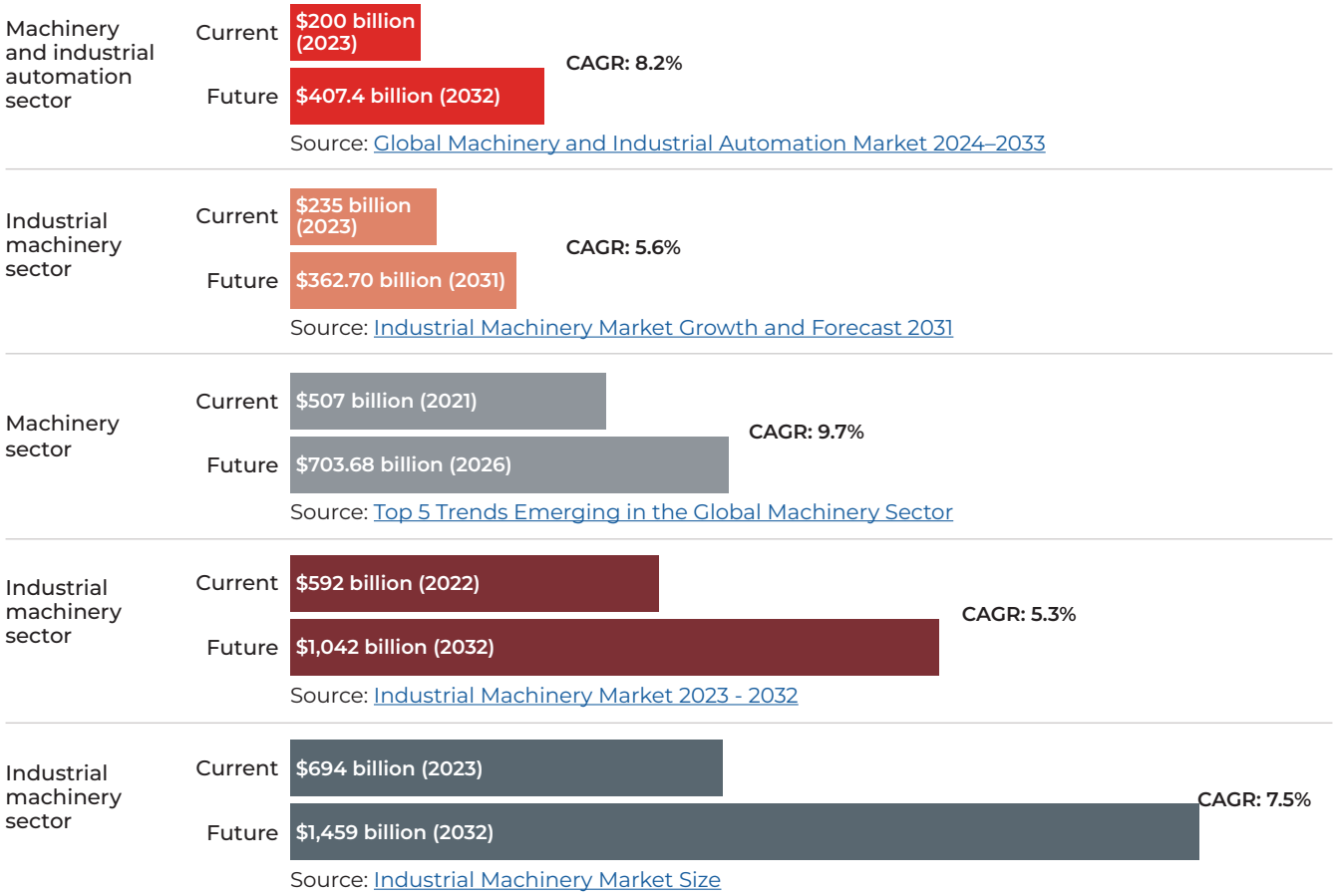
Source: SQW, based on AMPI material

A growing global market

2.3 The global advanced machinery market is worth around $500 billion, although individual estimates vary as shown below. It is also a growing market, with the compound annual growth rate (CAGR) expected to be between 5-10% over the next ten years.

[1] SQW analysis of BRES data for 2023

Table 2-1: Global advanced machinery market



Source: SQW analysis

UK performs relatively strongly on output, productivity and international trade

2.4 A recent report from the Institute for Manufacturing examined the UK's 'machinery and equipment manufacturing' (M&E) sector[2]. This covers a broader industry base than the 'advanced machinery' definition adopted later in this report, for example the M&E sector includes construction equipment. In addition, the data analysed is for 2021 and 2022, and the potential impact of the Covid-19 pandemic on this is unclear. Nevertheless, the report provides valuable insights into the UK's relative position internationally.

2.5 Data included in the report show that the UK ranked fifth amongst Organisation for Economic Co-operation and Development (OECD) countries by M&E manufacturing value added in 2021, see the table below. However, the value added for the US – the global lead – in this sector was eight times larger than the UK. Indeed, Italy is ranked one spot above the UK, but has a value added of more than double the UK total ($42 billion compared to $22 billion). The data also show that the UK's productivity in this sector is fifth amongst OECD members.

[2] https://www.ciip.group.cam.ac.uk/innovation/the-uk-innovation-report-2024/

2.6 There is an important caveat to the UK's fifth place ranking on value added. China is not an OECD member and (as shown in Figure 2-2 below) is the top net exporter in the global M&E manufacturing sector. In addition, South Korea is an OECD member but is not included in the analysis as data were not available. The UK's actual international value added ranking is therefore likely to be lower than fifth.

Table 2-2: Top 10 OECD countries for M&E manufacturing value added (2021)

OECD Country	Value added (US$, billion)	Labour productivity (US$, thousand)
US	174	149
Japan	155	93
Germany	132	115
Italy	48	101
UK	**22**	**137**
Netherlands	22	235
France	15	99
Switzerland	13	180
Sweden	13	163
Mexico	12	32

Source: Adapted from UK Innovation Report 2024 (Institute for Manufacturing) 2024

The UK still faces a machinery and equipment trade deficit

2.7 The same report also analyses UN trade data for the M&E sector, as shown below. It shows that the UK has a trade deficit in this sector. This deficit widened over 2011 to 2022 from $2 billion to over $7 billion, and was driven by a combination of increasing imports and reducing exports. The report suggests that the reduced exports are, at least in part, linked to Brexit making it more difficult for SMEs

in particular to export to European markets. It also notes a trend for UK firms to offshore manufacturing and keep only R&D and final assembly, testing and marketing activity in the UK. This vertical disintegration could help to explain the rise in imports. The potential opportunity around reshoring activity is considered later in this section.

Figure 2-2: Global ranking by trade balance in machinery and equipment manufacturing (2011 and 2022)

Trade balance 2011		
Rank	Country	USD billion
1	Germany	127.3
2	Japan	125.3
3	Italy	61.6
4	Netherlands	15.0
5	Switzerland	12.1
...		
144	**UK**	**-2.0**
...		
187	Canada	-24.6
188	Russian Federation	-38.5

Trade balance 2022		
Rank	Country	USD billion
1	China	167.5
2	Germany	102.2
3	Japan	89.7
4	Italy	50.1
5	Netherlands	21.7
...		
176	**UK**	**-7.2**
...		
187	Canada	-30.8
188	US	-102.5

UK exports		
2011 (USD billion)	2022 (USD billion)	CAGR (2011-2022)
44.2	42.0	**-0.5%**

UK imports		
2011 (USD billion)	2022 (USD billion)	CAGR (2011-2022)
46.1	49.2	**0.6%**

Source: UK Innovation Report 2024 (Institute for Manufacturing) 2024

2.8 Despite running an M&E trade deficit, the UK is still a significant M&E exporter, with total exports valued at $42 billion in 2022 (ranked 10th globally). This accounts for around 2.6% of global exports – a share which has been broadly consistent since 2011. China had the largest export market share in 2022 with 18.6% of the global market, and has overtaken Germany, the US and Japan since 2011.

Trends and drivers of change

2.9 The Institute for Manufacturing report identifies several trends influencing the M&E sector, many of which are relevant for advanced machinery. Perhaps most importantly, the M&E sector depends on demand from the wider manufacturing sector, which in turn depends on end user demand. Some elements of this are relatively stable – for example machinery for food processing as demand for food is inelastic – whilst others are more vulnerable to external shocks such as the Covid-19 pandemic.

> **In general, sales are tied to long-term investment plans of other companies**

Offshoring and the potential for reshoring

2.10 The report identifies a trend to offshoring because of high production costs (particularly for values and actuators where steel is a key input) and also because of Brexit especially for pumps and compressors, and for SMEs who lack the capacity to deal with the additional bureaucracy. As noted above, 'vertical disintegration' means that whilst machinery manufacturing is offshored, in many cases the R&D and design aspects are still performed in the UK.

2.11 Machinery user consultees (outside the defence sector) reported that the geography of machinery suppliers is of much less importance than the cost and performance of the machinery in question. This geographically agnostic purchasing behaviour amongst end-users has also contributed to the offshoring trend and a consequent weakening in UK machinery manufacturing capability.

2.12 However, with major disruptions to global supply chains caused by Covid-19 and the war in Ukraine, the offshoring/vertical disintegration trend may reverse over future years. Indeed, three consultees, referenced in section 2.4, argued that these factors emphasised the importance of the UK developing sovereign capability (and resilience) related to advanced machinery. Greater UK capability can also bring proximity benefits during the innovation process as buyers can test prototype machines more quickly and find it easier to collaborate on/influence the design process. Relatedly, a reshored UK advanced machinery sector would offer proximity advantages related to installation and maintenance, plus other wraparound support such as programming.

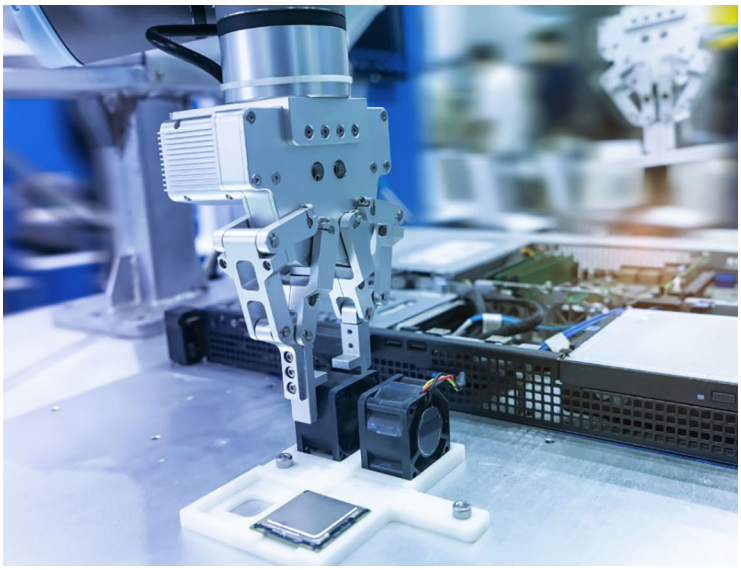
2.13 Consultees also reflected on challenges to the development of UK capability and capacity, and the concerted effort (from bodies such as AMPI and more broadly) that will be required to overcome the effects of previous offshoring. A key part of this would be for leading British purchasers to signal a focus on UK-based ordering to incentivise greater advanced machinery activity in the UK. Equally, advanced machinery firms will need to demonstrate – perhaps with support from AMPI – that they can produce the quality, reliable machinery needed by leading manufacturers.

Technology developments

2.14 Important technology developments and R&D trends identified in the literature and through consultations often related to underpinning digital technologies such as sensors/the Internet of Things and AI. When combined, these enable predictive maintenance using data analysis to monitor equipment status and prevent machine failures, thus reducing downtime and increasing reliability and efficiency. Advances in digital design and modelling are also enabling a move towards digital first design to reduce the need for physical testing and prototyping, and so accelerate the development of novel technologies.

2.15 Predictive maintenance is linked to, but distinct from, so-called 'servitisation' where machinery manufacturers offer a pay-per-use model and/or wraparound maintenance support as well as (or instead of) selling physical machinery. The servitisation trend was seen as being relatively well established and something that would continue to grow in prominence.

2.16 There are also advances in robotics – sometimes enabled by digital technologies, and many of which are supported by the work of academic partners on the AMPI Strength in Places Fund programme – which will have important implications for machinery manufacturers. This includes: cobots which are designed to work alongside humans rather than replace them; modular robotics where interchangeable modules can be assembled in different ways to enhance flexibility and cost-effectiveness; and enhances in reliability (related to the materials used and also the programming/control systems) which are allowing robotic components to work for longer, sometimes in harsher and more demanding environments.



Pick and place robot end effector

2.17 The general trend of a decline in the UK's machinery manufacturing capability over the past 50 years was noted. Indeed, one consultee commented that "gone are the days where the UK stands any chance of being a dominant force in out-and-out robotics manufacturing."[3] However, consultees identified opportunities for UK machinery companies in relation to the integration of robots in a factory setting (linked in part to the modular robotics point above). This links with a wider trend identified in the literature towards customisation where companies are moving towards more tailored systems that use 'off the shelf' machinery but deploy the kit in a highly specialised way to meet their specific needs. This creates an opportunity for UK manufacturers to customise generic systems and for UK installers to integrate them better. This may be facilitated by the innovation adoption activities of Made Smarter and the High Value Manufacturing Catapult, see Section 5.

2.18 Finally, environmental sustainability and the drive towards net zero is increasingly important across all sectors. This can be enabled by increasing the energy efficiency of machinery used across the manufacturing sector by enhancing the use of sensors and digital process controls in machinery to make manufacturing processes more efficient. In addition, the

[3] In contrast, the CEO of the National Robotarium has written about the growth of the global robotics technology market and the imperative for the UK to become "an active producer of robotics technology, creating high-skilled jobs and driving economic growth"

growth of industrial biotechnology/sustainable materials (instead of oil based materials) is likely to require the development of new production and processing techniques, which must be underpinned by enhanced machinery capabilities.

National policy context

Innovation and advanced machinery

2.19 The election of a new Government in 2024 means that the national policy context has changed. However, some documents published under the previous Government provide relevant context and are therefore summarised below:

- **UK R&D Roadmap (2021)**[4] – Highlighted that British businesses typically invest less in R&D relative to comparator nations, and established a goal of achieving 2.4% of GDP in R&D investment by 2027. It recognised the role of partnership working in achieving this, with collaboration between funders, academia, and industry described as essential to translate the UK's world-leading research capabilities into the development of new products and processes.
- **UK Innovation Strategy (2021)**[5] – The importance of the Advanced Materials and Manufacturing sector (to which Advanced Machinery belongs) was highlighted as it was recognised in the Strategy as one of seven technology families of strength and opportunity. The Strategy also outlined the introduction of schemes to attract and retain talent, and the identification of Innovation Missions (For example advancing healthcare, cleaner energy) to ensure innovation activities directly address the needs of the UK.
- **UKRI's 2022-2027 Strategy (2022)**[6] – Establishes how UKRI will seek to contribute towards the ambitions of the UK R&D Roadmap and Innovation Strategy. Priorities include delivering finance and collaboration opportunities to boost private sector investment, as well as strengthening support for commercialisation and knowledge exchange.

2.20 The new Government's approach to R&D is framed by **Invest 2035: the UK's modern industrial strategy (2024)**[7]. While recognising the UK's innovation strengths (e.g. high-quality research institutions and innovative firms), the Strategy acknowledges that this has only translated

[4] Department for Business, Energy and Industrial Strategy (2021) UK Research and Development Roadmap
[5] Department for Business, Energy and Industrial Strategy (2021) UK Innovation Strategy
[6] UKRI (2022) UKRI Strategy 2022-2027
[7] Department for Business & Trade (2024) Invest 2035: the UK's modern industrial strategy

into limited economic growth and export performance over the last decade. It specifically highlights the electrical machinery and equipment sector as an example, noting the importance of the sector for overall UK exports, but that its share of total exports is relatively low compared to other major economies. The Strategy focuses on removing barriers to growth and maximising opportunities to boost private business investment, and so boost the UK's international competitiveness.

2.21 As such, Invest 2035 sets out the Government's eight priority sectors identified for driving economic growth; advanced manufacturing is one of these. Net zero and digital transformation are highlighted as key opportunities for the sector, with the Government seeking to leverage the UK's world-class network of universities, research institutions and Catapults to accelerate innovation and drive productivity growth.

2.22 The finalised industrial strategy, along with individual plans for each of the priority sectors (including advanced manufacturing) was due to be published in Spring 2025 at the time of writing this report, in line with the multi-year spending review. The industrial strategy has since been published.

Innovation and place

2.23 The importance of place-based innovation has been reflected throughout key R&D documents published under the previous and current Governments. For example, the UK R&D Roadmap introduced "investing for places" to enable "places all over the UK to thrive and to fulfil their potential in R&D" and the UKRI Strategy includes a specific priority to "strengthen clusters and partnerships – locally, nationally and globally."

2.24 These policy drivers are reflected in a series of place-based innovation interventions with aims relating to R&D and commercialisation, as well as innovation ecosystem/cluster development more broadly. In addition to the SIPF which is funding the current AMPI activity, this also includes EPSRC's Place-Based Impact Acceleration Account, Innovate UK Launchpads, and the Innovation Accelerator[8].

2.25 The current Government has maintained a place-based emphasis. As part of Invest 2035, each Combined Authority will develop their own 10-year Local Growth Plans, setting

[8] Place Based Impact Acceleration Account and Innovate UK Launchpads

out how they will use greater devolved powers and funding to drive growth in their region. These local plans will represent strategic partnerships between combined authorities and central government to identify priorities for growth and ensure alignment with the broader national industrial strategy.

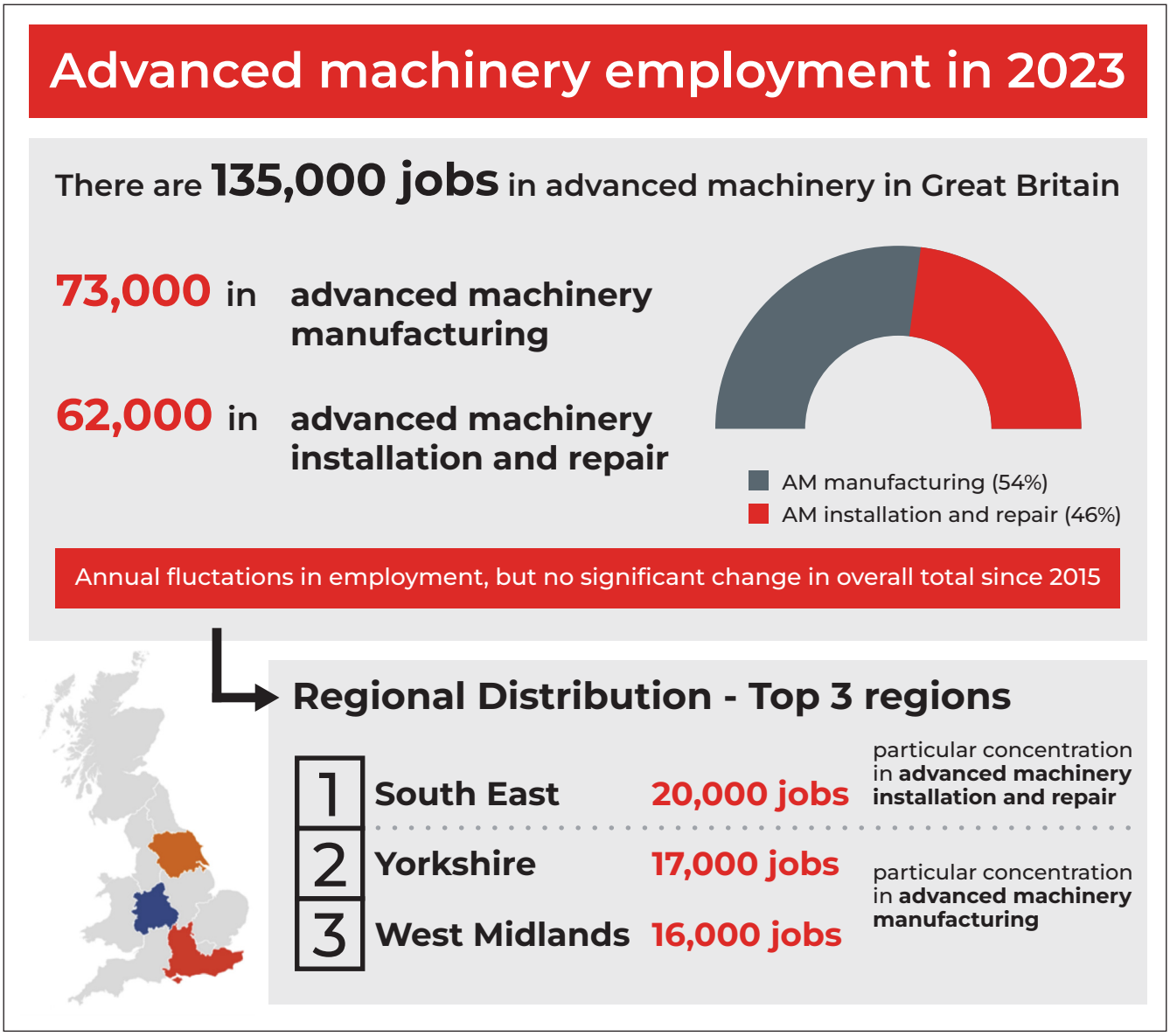
2.26 The **English Devolution White Paper (2024)** sets a precedent for a continued widening of devolution, with an intention to deliver integrated settlements for six established Combined Authorities (including Greater Manchester in FY2025/26 and West Yorkshire in FY2026/27)[9]. The integrated settlements will provide greater flexibility for Mayors to fund priorities which are most important to their region, and enable them to deliver against longer-term local objectives. In addition to integrated settlements, the White Paper proposes that Combined Authorities develop plans for regional innovation funding programmes within their area, while also being tasked with developing market investable propositions for significant, commercially viable opportunities (in collaboration with the Office for Investment). In short, this will grant Combined Authorities more control over their local innovation ecosystem, allowing them to better align innovation activities with local strengths, opportunities, and priorities.

Manchester, United Kingdom

[9] Ministry of Housing, Communities & Local Government (2024) English Devolution White Paper

3. Advanced Machinery in Great Britain

Figure 3-1: Employment – the headline numbers



Source: SQW

Advanced machinery employment

3.1 Advanced machinery related employment can be relatively well defined using Standard Industrial Classification (SIC) codes. The SIC codes make a distinction between the manufacturing of this machinery (12 individual codes within SIC28: Manufacture of machinery and equipment n.e.c.[10])

[10] Note that "30300: Manufacture of air and spacecraft and related machinery" is excluded from the definition as it captures general aerospace manufacturing as well as manufacturing machinery for aerospace.

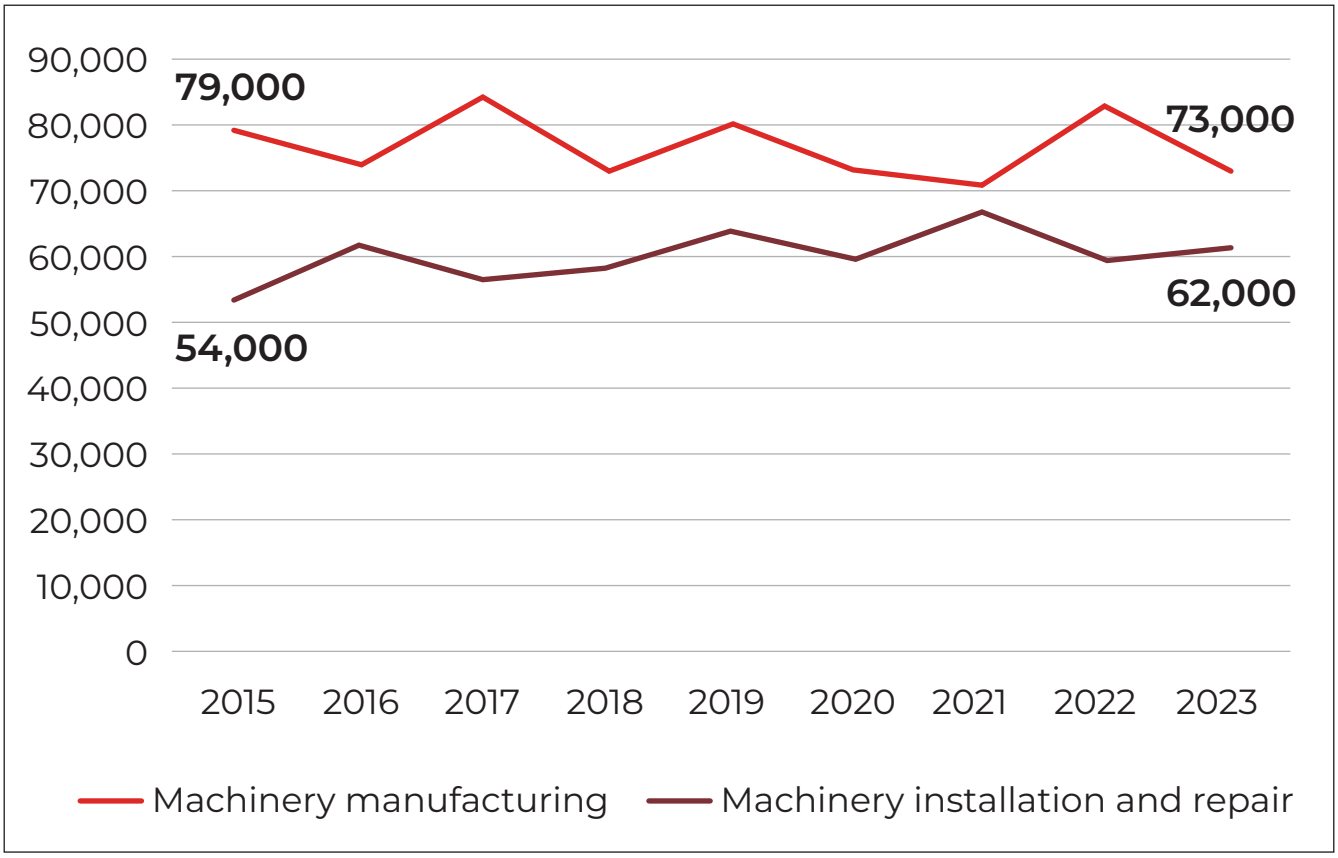
and its installation and repair (two codes within SIC33: Repair and installation of machinery and equipment). The latest available data on employment by sector is for 2023.

Advanced machinery employment was 135,000 in 2023

3.2 In 2023, total advanced machinery related employment in Great Britain[11] was 135,000, almost equivalent to the 2015 figure. This represents around 6% of all manufacturing employment across GB in 2023.

3.3 As shown in the chart below, almost 55% of the total advanced machinery related employment is in advanced machinery manufacturing, with the remaining c.45% in installation and repair. There is no clear annual pattern to changes in employment figures with the advanced machinery manufacturing element representing between 50-60% of machinery employment each year. Interestingly, there was no significant drop in employment during 2020 because of Covid-19. This may reflect the long lead times and long in-service life of advanced machinery which helps to avoid short term fluctuations.

Figure 3-2: Employment in manufacturing and installation/repair (2015-2023)



Source: SQW analysis of BRES data

[11] Consistent data is not available for Northern Ireland.

Employment is dominated by three sub-sectors

3.4 Of the 73,000 employed in advanced machinery manufacturing across the UK, over half are employed in the two largest sub-sectors:

- 'Other general purpose machinery' captures a wide range of activity, including manufacturing of weighing machinery, centrifuges, packing machines, rolling machines, and machines for cleaning and drying bottles. In geographic terms, employment is particularly concentrated in Yorkshire (4,000 jobs, LQ of 2.4[12]) and underrepresented in Scotland (900 jobs, LQ of 0.5).
- 'Lifting and handling' includes the manufacture of mechanical manipulators and industrial robots designed for lifting and loading/unloading, as well as manufacture of power-driven lifting machinery such as derricks and cranes. Slightly over a third of employment in this subsector is in the West Midlands and Yorkshire (both with 3.500 jobs and LQs of 2.2 and 2.3 respectively).

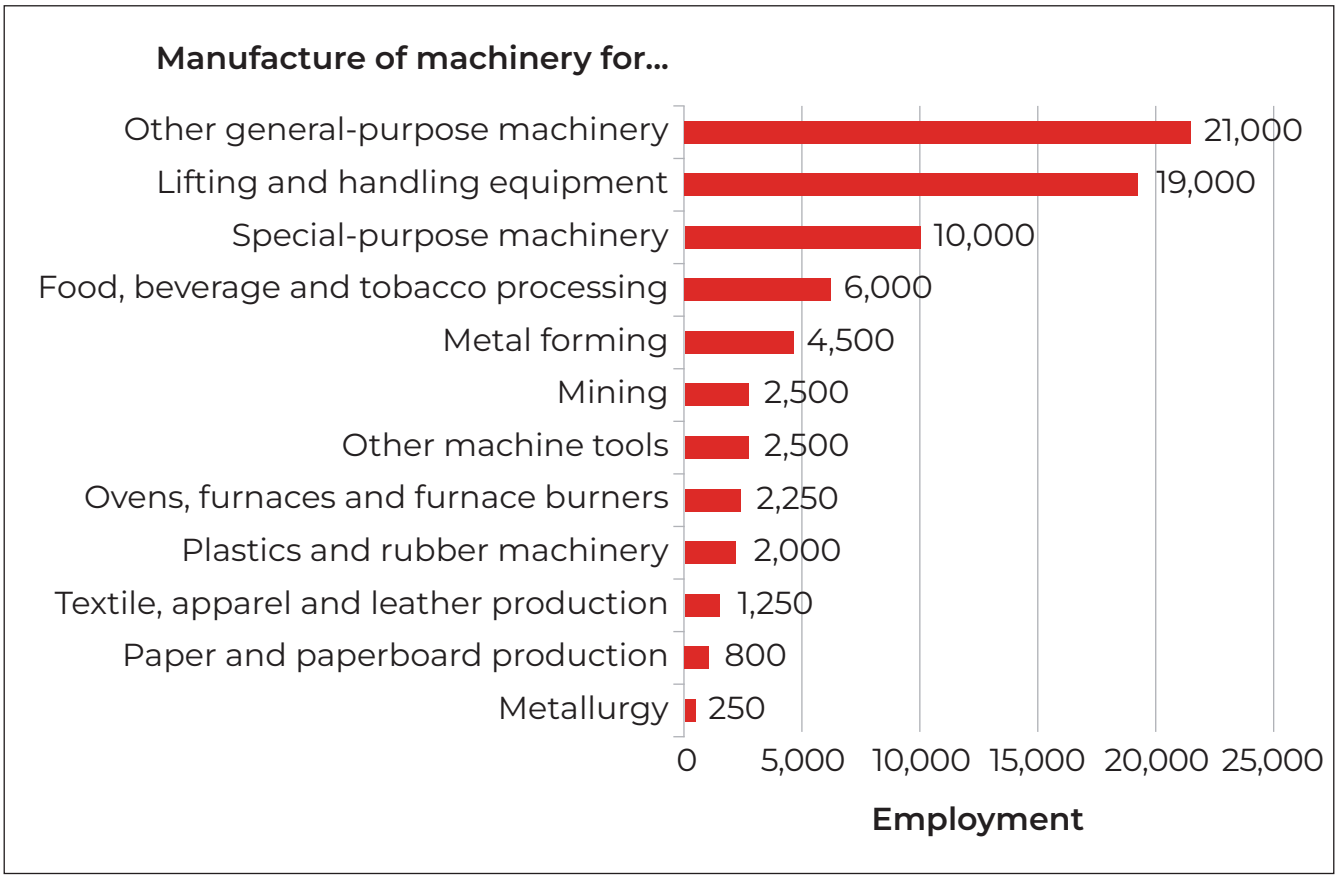
3.5 A further 14% of employment is in 'special purpose machinery' manufacturing – the top three subsectors therefore account for almost 70% of all machinery manufacturing employment. 'Special purpose machinery' is defined as "machinery for exclusive use in a specific industry or a small cluster of specific industries."[13] Employment is particularly concentrated in Wales, the East of England and Yorkshire (LQs of 2.3, 2.2 and 1.9 respectively).

3.6 The dominance (in employment terms) of the main three sub-sectors has been consistent since 2015. These three sub-sectors manufacture machines which can be applied by a wide variety of sectors, which perhaps explains the high employment figures when compared to sub-sectors which focus exclusively on manufacturing machinery for a single sector or market segment such as textiles or paper production, see the chart below.

[12] A Location Quotient (LQ) shows the concentration of jobs in a given sector in a region compared to the GB average. An LQ of over 1 indicates a higher concentration of jobs in a given sector than the GB average, whilst an LQ under 1 indicates a lower concentration of jobs than average.

[13] UK Standard Industrial Classification of Economic Activities 2007 (ONS)

Figure 3-3: Employment in advanced machinery manufacture (2023)



Source: SQW analysis of BRES data

Advanced machinery businesses

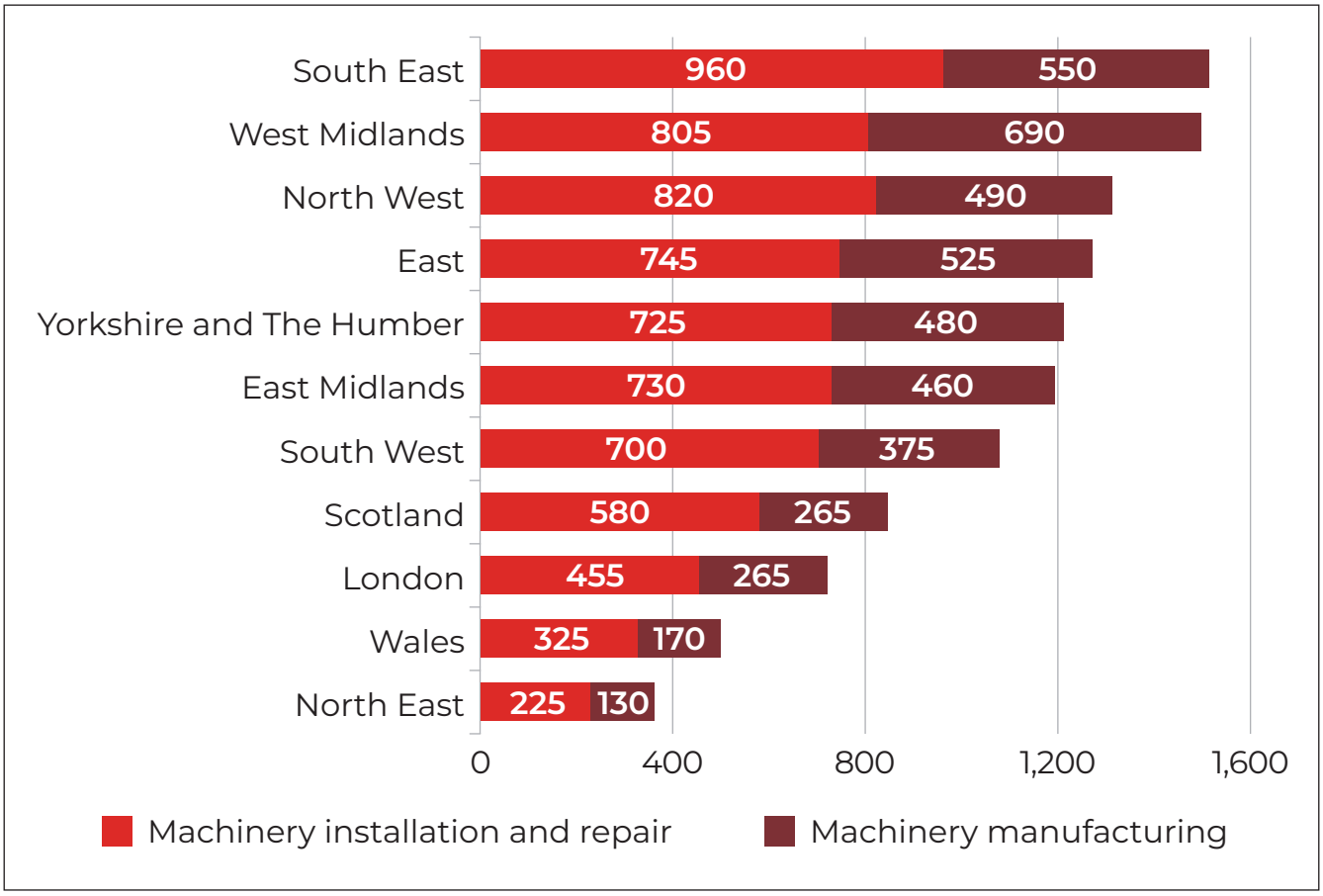
11,500 advanced machinery enterprises

3.7 In 2023, there were almost 11,500 advanced machinery enterprises in Great Britain, around 10% higher than the 2015 figure.[14] In contrast to the trend for employment, around 60% of these businesses were in advanced machinery repair and installation, with the remaining c.40% in advanced machinery manufacturing. In 2015, the split between manufacturing and repair and installation was roughly even.

3.8 The regional distribution of advanced machinery enterprises is shown in the chart below. The South East has the largest total number of enterprises, including the largest number of installation and repair enterprises and the second largest number of manufacturing enterprises (behind the West Midlands). The South East and West Midlands combined account for a quarter of all advanced machinery enterprises.

[14] SQW analysis of UK Business Counts (Enterprises). This dataset includes statistics for the UK, whilst the BRES data on employment only covers GB. In 2023, there were 11,950 advanced machinery enterprises in the UK.

Figure 3-4: Advanced machinery enterprises by region (2023)

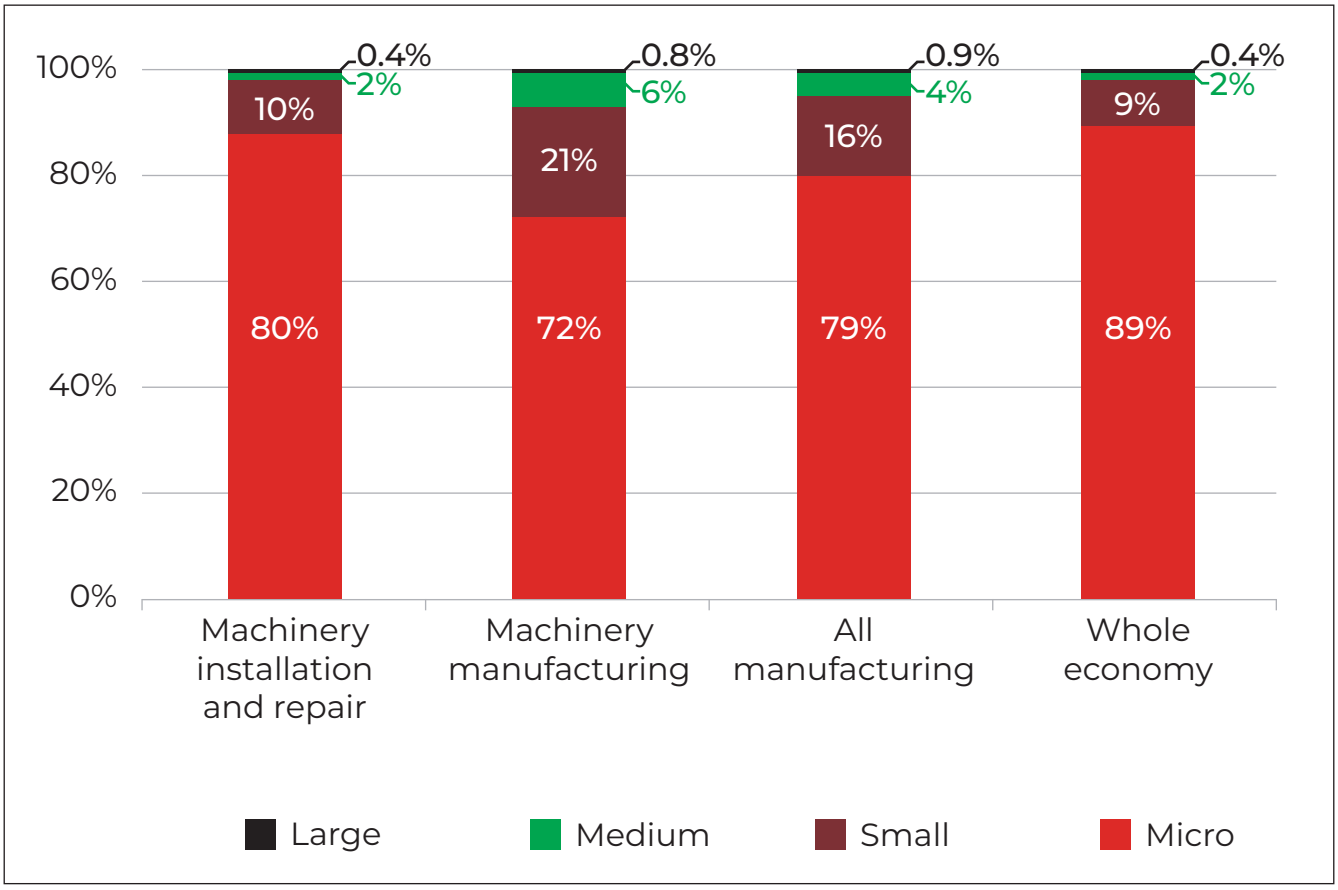


Source: SQW analysis of UK Business Counts

… with a large percentage of small and medium manufacturing enterprises

3.9 The chart below shows the distribution of advanced machinery enterprises by employment size band. The distribution of machinery manufacturing enterprises is notably different to the whole economy GB average with larger proportions of firms in the small and medium categories (10 to 49 employees, and 50 to 249 employees respectively), and a lower proportion of micro businesses (up to nine employees). In comparison to all manufacturing sectors, machinery manufacturing still has a higher proportion of firms in the small and medium categories.

Figure 3-5: Advanced machinery enterprises by employment size band (2023)



Source: SQW analysis of UK Business Counts

A highly productive sector

3.10 Productivity data are available for the broader M&E sector. Encouragingly, this sector is highly productive, with productivity (measured by value added per employee) of £102,000 in 2021. This is 60% higher than the UK whole economy average and almost 40% higher than the average for the whole manufacturing sector. Indeed, M&E sector productivity was consistently higher than wider manufacturing productivity over the 2011 to 2021 period.[15] In light of the UK's stubbornly persistent productivity challenges, this is a positive finding and should form the cornerstone of the case or rationale for increased public investment to boost the sector.

3.11 Over the same period, M&E productivity grew from £91,000 to £102,000. In contrast, business enterprise expenditure on R&D (BERD) in the sector was relatively stable at around c.£1 billion per year. The Institute for Manufacturing suggests that this is because the sector is dominated by SMEs, which might have fewer resources available for R&D than large OEMs in other manufacturing sub-sectors such as aerospace.

[15] Institute for Manufacturing, see Annex B for more details

Regional distribution of employment

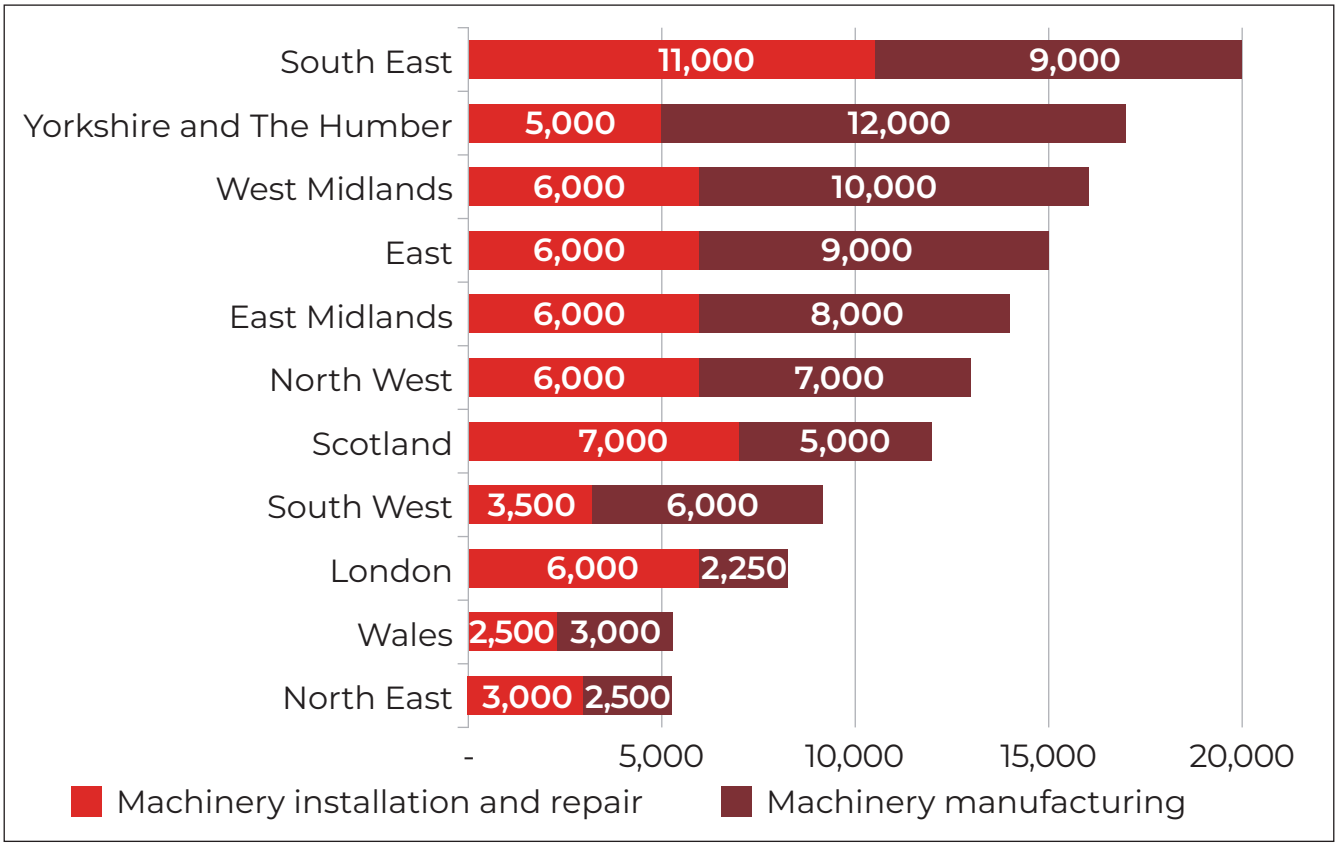
Employment distribution across the UK

3.12 The South East has the highest absolute levels of advanced machinery related employment – with its c.20,000 jobs driven by a high installation and repair figure – followed by Yorkshire and Humber and the West Midlands with c.17,000 and c.16,000 jobs respectively. Three other points are made in relation to the chart below:

- The South East employment in installation and repair is 4,000 higher than for any other region (11,000 in the South East vs 7,000 in Scotland).
- Yorkshire and the Humber has the highest absolute employment in advanced machinery manufacturing, ahead of West Midlands (12,000 and 10,000 respectively).
- At a GB level, advanced machinery manufacturing represents around 55% of machinery related employment (with the remaining 45% of employment in 'installation and repair'). London is the major exception to this, with c.75% of its advanced machinery employment in installation and repair. Yorkshire is an outlier in the other direction, with c.70% of its machinery related employment in manufacturing.

Engineer being trained on a manual lathe

Figure 3-6: Advanced machinery employment per region



Source: SQW analysis of BRES data

3.13 The analysis here is presented at the regional level, but it is important to note that there are very localised concentrations of employment around specific hubs within each region. District level employment is considered at the end of this Section.

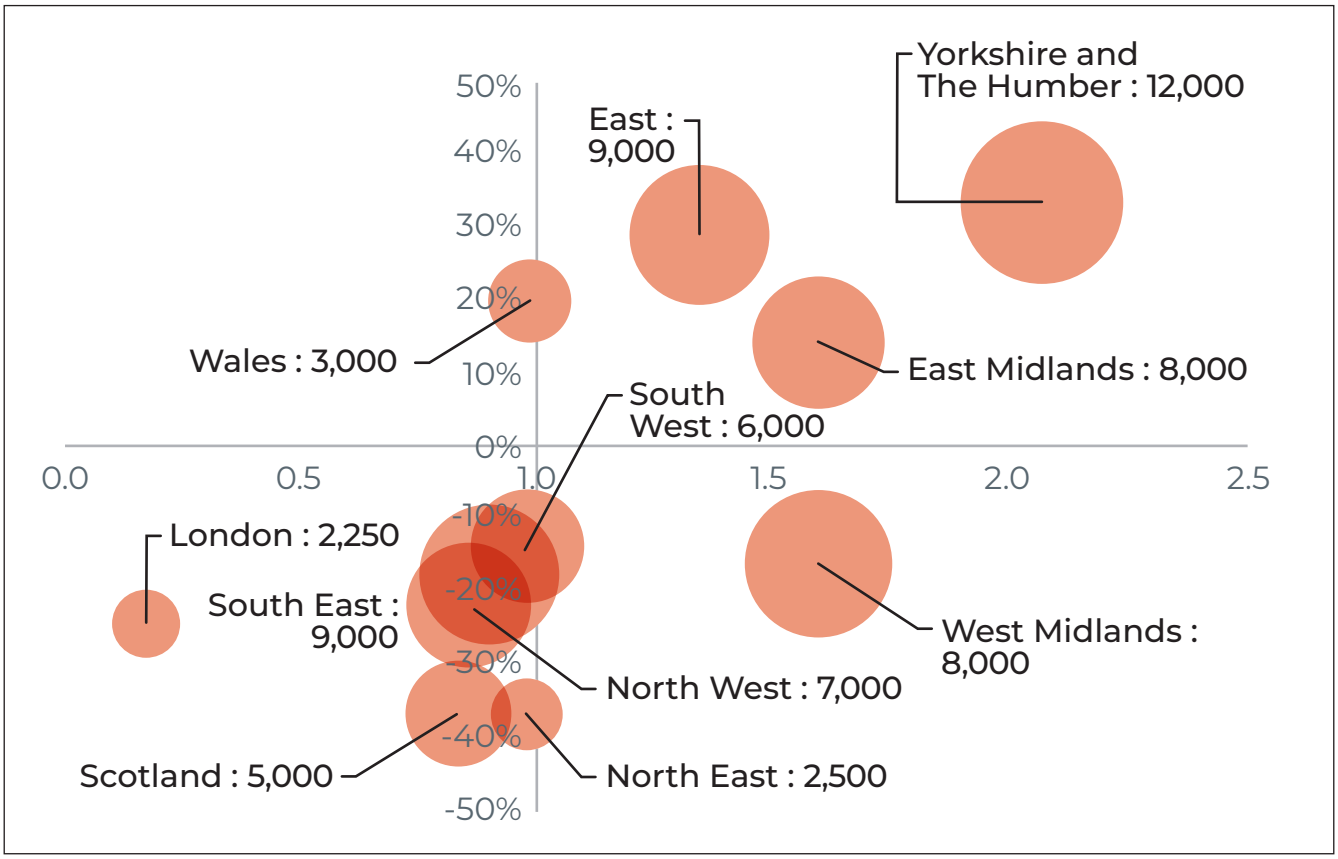
Advanced machinery manufacturing is particularly concentrated in Yorkshire and The Humber

3.14 The following bubble chart shows absolute employment in advanced machinery manufacturing (excluding installation and repair which is covered in the following sub-section), concentration of employment (on the x-axis) and employment growth between 2015 and 2023 (on the y-axis). Three points are made:

- Yorkshire has the largest, most concentrated and fastest growing employment over the 2015-2023 period.
- The West and East Midlands, and East of England also have concentrations of advanced machinery manufacturing employment. With the notable exception of London, the employment concentration in other areas is broadly in line with the national average for machinery manufacturing.

- Employment in the West Midlands remains large and concentrated, but has declined since 2015. Scotland and the North East have seen the largest relative declines, with advanced machinery manufacturing employment in 2023 almost 40% below the 2015 figure for these regions.

Figure 3-7: Regional employment in advanced machinery manufacturing (2015-2023)



Source: SQW analysis of BRES data. Size of bubbles = employment in region; X-axis = Location quotient (LQ); Y-axis = change in employment in region, 2015-2023

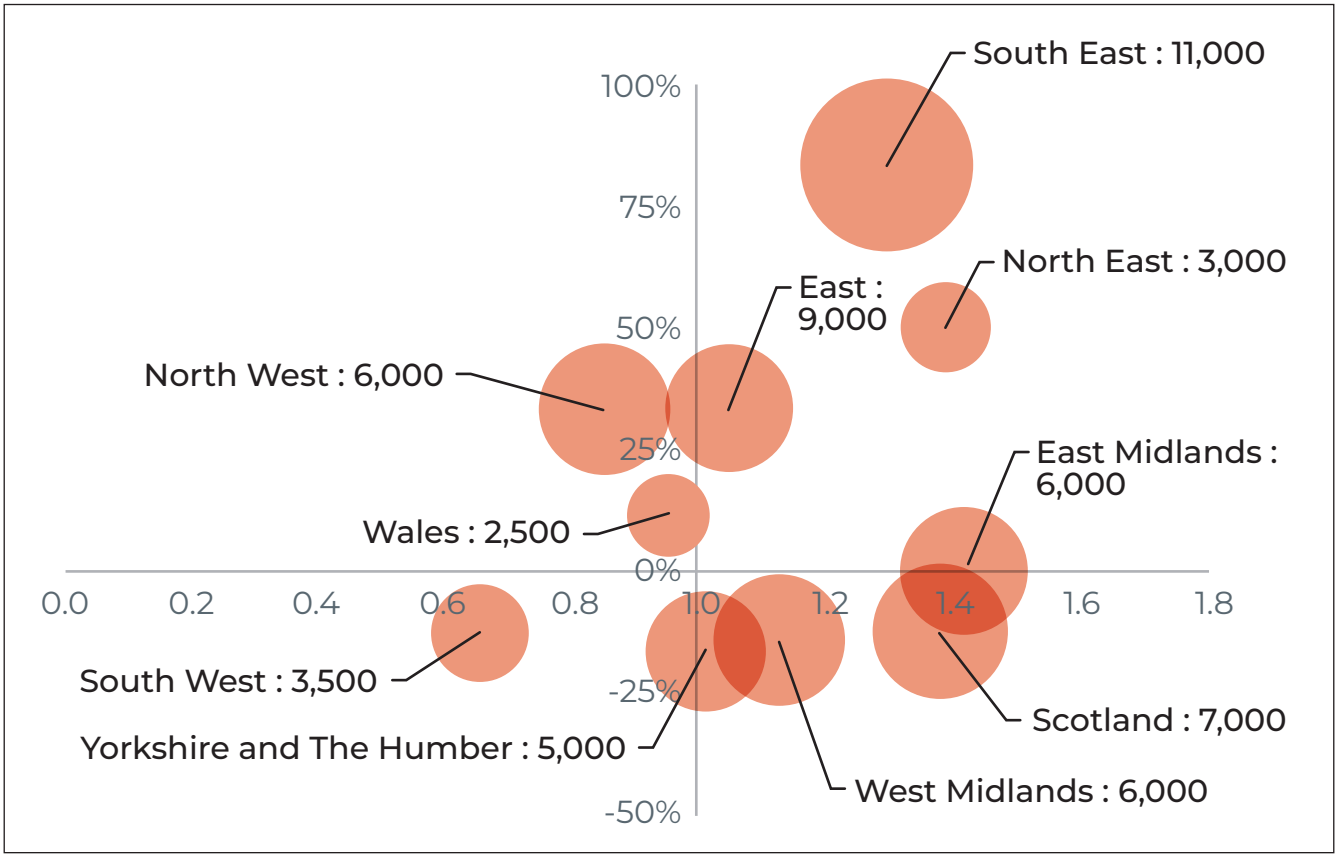
Installation and repair is particularly prominent in the South East

3.15 The following bubble chart shows regional employment in machinery installation and repair. Four points are made:

- London is excluded as it has seen employment growth of 140% over 2015-2023, although from a relatively low base
- The South East has the highest absolute value of installation and repair employment, and one of the highest levels of concentration.
- The East Midlands and Scotland have similar levels of employment and concentration (607,000 jobs, with a concentration of 1.4) but different growth trajectories since 2015, with installation and repair employment in Scotland declining by 13% compared to no change in East Midlands.

- The South West has a low and declining level of advanced machinery installation and repair employment, as well as a low concentration of employment.

Figure 3-8: Regional employment for advanced machinery installation and repair (2015-2023, excl. London)

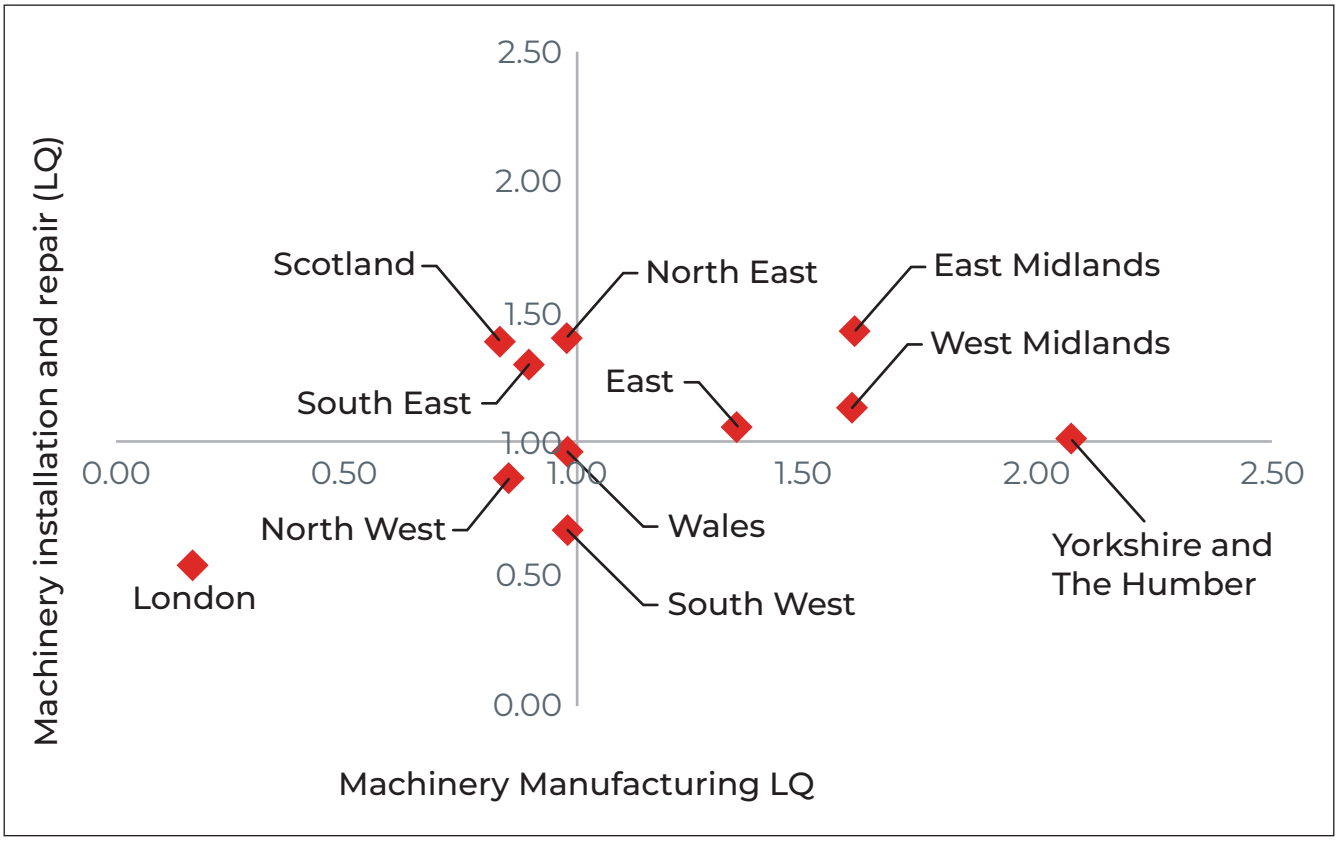


Source: SQW analysis of BRES data. Size of bubbles = employment in region; X-axis = Location quotient (LQ); Y-axis = change in employment in region, 2015-2023

No clear relationship at a regional level between concentrations of advanced machinery manufacturing and installation and repair employment

3.16 The chart below considers the concentration of regional employment in advanced machinery manufacturing (x-axis) and installation and repair (y-axis). There does not appear to be a clear relationship between the two elements of advanced machinery employment. Some regions have concentrations in both elements (East and West Midlands), other regions have a concentration in one or other element (Such as Yorkshire on manufacturing but not installation), whilst London and the North West do not have a concentration in either category.

Figure 3-9: Concentration of regional employment (2023)



Source: SQW analysis of BRES data

Comparing sub-sectors across regions

3.17 Advanced machinery employment can be divided into 14 sub-sectors (12 related to manufacturing and two related to installation and repair). A full breakdown of employment concentration by region and sub-sector is provided in Annex B. Four headline points are made:

- **Yorkshire has above average concentrations of employment across multiple sub-sectors.** Yorkshire has the highest level of machinery manufacturing employment at 12,000 jobs. It has higher levels of employment than the GB average in nine of the 12 machinery manufacturing subsectors suggesting a broad industrial base.
- **The majority of regions have a significant concentration of employment in at least one sub-sector.** For example, the West Midlands has an LQ of 3.1 (which is three times the GB average) for employment in the manufacture of ovens, furnaces and furnace burners. The North West has an LQ of four (four times the GB average)

for employment in the manufacture of machinery for paper and paperboard production (although the actual employment figure is relatively small at 350 jobs). Yorkshire has employment concentrations more than double the GB average in six machinery manufacturing sectors: ovens, furnaces and furnace burners; lifting and handling equipment; other general-purpose machinery; metal forming machinery; machinery for metallurgy; and machinery for food, beverage and tobacco processing.

  - ▹ **Three regions are exceptions to the employment concentration rule. London, North East and South East are the only regions not to have an employment concentration of above two (double the GB average) for any manufacturing sub-sector.**

- **London and Wales are underrepresented in employment terms across multiple sub-sectors**. Conversely, London is underrepresented in all 12 machinery manufacturing subsectors, whilst Wales is underrepresented in 11 subsectors (manufacture of special purpose machinery is the exception, and is highly concentrated with an LQ of 2.3).
- **Sub-sectors can be small and concentrated.** The manufacturing of machinery for metallurgy, paper production, plastics and mining is small in employment terms across GB (totals of 250, 800, 2,000 and 2,500 respectively). However, this employment is highly concentrated, with metallurgy machinery in the South West and Yorkshire (LQs of 7.1 and 2.5 respectively), paper production in the East, East Midlands and North West (LQs of 3.4, 2.7 and 4 respectively), plastics machinery in the East (LQ of 2.2) and mining machinery in Scotland (LQ of 7).

District level employment

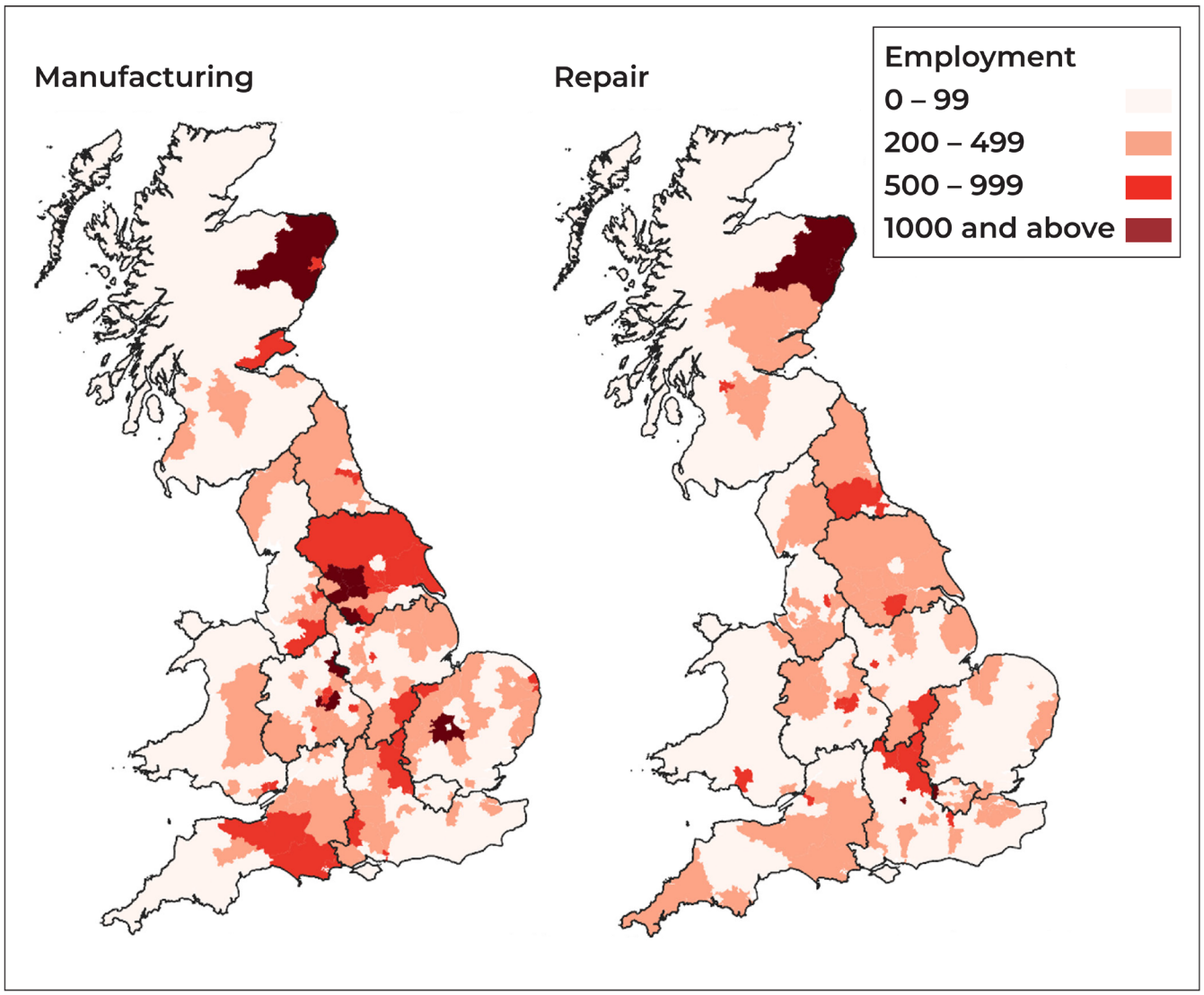
3.18 The maps below show how advanced machinery employment is distributed across local authority districts within the broader regions. Overall, the maps show that employment is distributed across GB, with some pockets of concentration.

3.19 District level data for manufacturing shows high levels of employment across Yorkshire, particularly the West Yorkshire districts of Bradford, Wakefield, Kirklees and Leeds, as well as Sheffield (over 1,000 jobs each). Within the Midlands, the districts of East Staffordshire, Dudley,

Birmingham, Sandwell and Worcester are prominent (over 800 jobs each). South Cambridgeshire and Aberdeenshire plus Aberdeen City are more isolated areas of high manufacturing employment.

3.20 Aberdeenshire and Aberdeen City have the highest levels of installation and repair employment (over 1,250 jobs in each), perhaps reflecting the presence of the oil and gas industry. There is an arc of employment to the north west of London stretching between Hillingdon, Reading, Buckinghamshire, Cherwell and, to a lesser extent, Milton Keynes (500 jobs in Milton Keynes, but at least 800 jobs in the other districts). There are also more isolated areas of high repair employment across GB such as Doncaster, Bury, Derby, County Durham and Newport (at least 500 jobs in each place).

Figure 3-10: Advanced machinery employment at district level (2023)



Source: SQW analysis of BRES data

3.21 Districts with the highest levels of employment in advanced machinery manufacturing tend not to have the highest levels of employment in repair. Aberdeenshire is the only district to be ranked in the top ten for both employment and repair. Dudley, Sandwell and North Northamptonshire are in the top 15 districts for both manufacturing and repair employment.

Implications for AMPI

3.22 Advanced machinery employs around 135,000 people across 11.5,000 enterprises across Great Britain. This represents around 6% of all manufacturing employment and 9% of all manufacturing enterprises across GB in 2023.

3.23 Three factors are particularly relevant for designing and targeting innovation support through AMPI:

- **Distinctive business characteristics.** Advanced machinery manufacturing has a different structure in terms of business size than the wider manufacturing sector, and indeed the whole economy. There is a higher proportion of small and medium firms, with lower numbers of micro firms.
- **Geography.** Employment and enterprises are distributed across the UK. The South East and West Midlands are particularly prominent in absolute numbers, but the majority of regions have a significant concentration of employment in at least one advanced machinery sub-sector. London and the North East have low levels of absolute employment and do not have a significant concentration in any-subsectors.
- **Diversity within the sector.** Almost 55% of the total advanced machinery related employment is in advanced machinery manufacturing, with the remaining c.45% in installation and repair. These different groups of businesses may have different support needs.

4. Learning from elsewhere

Summary

- Case studies of advanced machinery clusters in Aachen, Germany and the Basque Country, Spain as well as a broader advanced manufacturing cluster body in Canada highlight that it takes time to establish successful clusters, and that sustained public sector funding (at scale) is required to do so.
- The Aachen and Basque Country clusters utilise geographic proximity, whilst NGen in Canada covers a much broader spatial area by relying on temporary proximity (multi-day, face-to-face visits), cognitive proximity (the extent to which collaborators share a common knowledge base), and/or social proximity (the strength of trust and the effectiveness of working relations between stakeholders).
- Other implications from the case study research are that: initiatives should be industry-led rather than research-driven; SMEs must be involved in both the design and delivery of activity; and the importance of being outward looking and continuously seeking to promote exporting and wider international business opportunities.
- There are also important process issues to overcome in starting a new organisation, including forming a suitable board of directors, establishing programme selection processes, putting reporting requirements and secretariats in place, and developing an appropriate long-term strategy.

Aachen, Germany

4.1 Aachen, a city located in the West of Germany, is renowned for its advanced machinery cluster. The cluster is centred around a strong research base, with institutes such as Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen University providing extensive research facilities and expertise in mechanical engineering, materials science, and production technology. Aachen, and Germany more widely, is also home to many industrial players in the tool building industry.

4.2 This case study has been informed by a review of online resources including company websites and material published by key factors such as the RWTH Aachen University's Machine Tools and Production Engineering Laboratory (WZL). Representatives from the Fraunhofer Institute for Production Technology and WZL were approached to take part in a consultation to support the case study, but did not respond.

Current activity in the cluster

4.3 The advanced machinery cluster in Aachen emerged with the development of WZL, founded over 100 years ago. WZL conducts research and innovation on production technology. RWTH Aachen University has a strong focus on engineering and technology, ranking 34th in the world in these disciplines.[16] It also ranks first among German universities in Industrial Engineering and third in Mechanical Engineering and Electrical Engineering. The research carried out at WZL is characterised by cross-disciplinary collaboration and a balance between "pure research" and "applied development".[17] The latter requires close collaboration with industry to ensure results find rapid application in an industrial context. In addition to conducting research and collaborating with industry, WZL also focuses on the applied teaching of young engineers. The institute ensures that insights gained from research activities flow directly into university teaching of production engineering.

4.4 A second anchor institution within the cluster is the Fraunhofer Institute for Production Technologies (IPT), which was founded in 1980. The Fraunhofer IPT is one of 76 institutes operated by the Fraunhofer-Gesellschaft, a world-leading applied research organisation.[18] The institute focuses on process technology, production machines, production quality and metrology, and technology management. It employs around 480 people in Aachen and aims to help companies achieve "climate friendly and sustainable production".[19] There is strong collaboration between the Fraunhofer IPT and WZL, with the two organisations sharing a Board of Directors "to form a production technology research centre that is unequalled in diversity and competencies".[20]

[16] RWTH (2024) RWTH Aachen
[17] WZL (Undated) Modern Production Technology Based on Practical Research
[18] Research in Germany (Undated) Research Landscape
[19] Fraunhofer IPT (Undated) Fraunhofer IPT Profile
[20] Fraunhofer IPT (2024) Directorship

4.5 The Fraunhofer IPT and WZL work collaboratively to deliver the Aachen Machine Tool Colloquium (AWK). The AWK is a two-day conference held every three years, which attracts over 1,200 experts from c.360 companies. It features presentations, workshops and exhibitions to provide a platform for learning, knowledge exchange and networking for professionals within the field of advanced machinery.

4.6 More widely, the sector is supported the German Machine Tool Builders Association (VDW) established in 1891. In partnership with the Sector Association Machine Tools and Manufacturing Systems (within the German Engineering Federation), the VDW comprises approximately 300 member companies. It provides domestic and international advocacy for its members, and offers services including monitoring business trends, gathering market data, addressing legal matters, fostering collaboration with the global machine tool industry, promoting standardisation, and supporting recruitment.[21] The VDW is a pan-German organisation, but supports organisations within the Aachen cluster through access to its events, resources and advocacy.

Frankfurt, Germany

4.7 In addition to its world-renowned research institutes and supporting industry bodies, the Aachen cluster includes strong industrial activity, with a mix of local SMEs and global corporations. Key companies with a presence in Aachen include:

- TRUMPF provides manufacturing solutions for machine tools, laser technology, electronics and Industry 4.0. It was founded in 1923 and has grown to an annual turnover of over €5 billion, with 19,000 employees internationally.[22] TRUMPF has presence in Aachen through its photonic components division.
- Siemens AG focuses on intelligent infrastructure for buildings and decentralised energy systems, on automation and digitalisation in the process and manufacturing industries, and on smart mobility solutions for rail and road transport. It has presence in over 200 countries/regions, including in Aachen, and employs roughly 311,000 people.[23]

[21] VDW (Undated) The German Machine Tool Builders' Association (VDW)
[22] TRMPF (2024) Company Profile
[23] AWK (2023) Co-hosts
[24] Ericsson (2024) Ericsson in Aachen

- Ericsson creates state-of the art cellular technology and services. Alongside Siemens they are a co-host of the AWK conference. Aachen is home to Ericssons Eurolab, which is one of the company's largest R&D centres in Europe, employing over 600 R&D Engineers.[24]
- Fecken Kirfel produces precise cutting machines for flexible foam, solid plastics as rubber and neoprene, rigid foam and cork. The firm was founded in 1870 in Aachen, and now has a "global focus" with representatives in 35 different countries. It remains an SME, employing up to 200 people.[25]
- AMBA is an Aachen-based SME employing around 80 people.[26] It designs and manufactures specialist machinery and components for the metals processing industry. It has clients spanning 20 different countries.
- Esco develops software products and integrated solutions for automated manufacturing and quality control for machine tool manufacturers, measuring equipment manufacturers and manufacturing companies.[27] The firm is based in the TPH technology park, just north of Aachen.
- Allaoui Graphic Machinery is a supplier of pre-owned printing, bindery, and packaging machinery. It is a small family-run business which works with clients from all around the world, purchasing and selling used graphic machinery of all kinds.

4.8 As demonstrated by the list above, the Aachen machinery cluster has a range of technological specialties and serves a variety of sectors and geographies. Many companies reach global markets and have a strong emphasis on exporting. Sectors mentioned in the AWK programme guide suggest a particular focus on machinery for the automotive, aerospace, medical technology and energy sectors.[28]

Key success factors

4.9 SQW's analysis of the documentation suggests that a number of factors have enabled the success of the Aachen advanced machinery cluster. First, the cluster has benefitted from **significant public sector support** over the years, from both local and national sources. For example, the federal and state governments in Germany have funded various research initiatives including the Cluster of Excellence "Internet of Production" at RWTH Aachen University. The project started in 2006 and focuses on the digital transformation of production technology. It involves more

[25] LinkedIn Fecken Kirfel
[26] AMBA (Undated) Company Profile
[27] Esco (Undated) Company Profile
[28] AWK (2023) Program

than 85 scientists from over 25 research institutes and research facilities of RWTH Aachen University. Overall, the majority of research carried out by WZL is publicly funded. More generally, Germany has a long history of public sector support for research and innovation, notably through the Fraunhofer network which receives approximately 30% of its funding from the public sector.[29]

4.10 Another important success factor is the close **collaboration between the anchor research institutes and industry**. Research at WZL, for example, is generally carried out in collaboration with one or more companies.[30] The high level of industry engagement in the Aachen cluster is evident at the AWK conference, where players from across the industry are actively engaged and the research agenda is demand-led. Speakers at the latest conference (2023) included experts from Airbus, BMW, Bosch, Ford, and Siemens.[31] Moreover, the event itself is hosted by WZL and in 2023 it was co-hosted by Ericsson, Siemens and Hexagon. Partners also included a number of other companies such as GF Machining Solutions, Igus, Insphere, and Kabel Schlepp. Linked to the above point, many of the research initiatives funded by the German government have a strong focus on industry collaboration. For example, the Fraunhofer model is designed to foster innovation through close partnerships between the research institutions and industry.

4.11 A final notable success factor relates to the **outward looking nature and global reach** of advanced machinery firms in the Aachen cluster. Many Aachen based SMEs have business models that focus on exporting their products and services to international markets. This is facilitated by Germany's strong reputation for high-quality engineering and manufacturing. Events organised within the cluster, such as AWK, further add to its global reputation. For example, AWK attracts participants from around the world and provides Aachen-based SMEs with opportunities to showcase their innovations, network with global industry leaders, and learn about the latest trends in production technology.

Key challenges

4.12 Although many of the firms in the Aachen cluster are export-focused, the cluster is still likely to be adversely affected by the challenges currently facing the German economy. A

[29] Institute for Plastics Processing (Undated) Cluster of Excellence Research, RWTH Aachen (2023) Cluster of Excellence "Internet of Production", WZL (2020) Funding bodies and Fraunhofer (2024) Finances
[30] WZL (Undated) Modern Production Technology Based on Practical Research
[31] AWK (2023) Programme
[32] German Chamber of Commerce and Industry (2024) German economy is losing ground

recent IMF forecast ranked Germany 39th in terms of growth among 41 advanced economies.[32] German manufacturers appear to be particularly badly affected by the slowdown in growth. For example, half of companies in the automotive sector are currently reporting financial difficulties, whilst 30% of parts and accessories manufacturers face tougher access to external capital.[33] Relatedly, there are concerns around an over dependency on imports to the German manufacturing industry, such as lithium batteries required in the automotive industry.[34] A decline in German manufacturing is likely to mean lower demand for advanced machinery.

4.13 Further challenges faced by the Aachen cluster are likely to be similar to those faced by established advanced machinery clusters elsewhere. They relate to key themes such as: remaining internationally competitive over the long term[35]; reducing environmental impact[36]; and adapting to digital transformation, especially integrating advanced digital technologies across SMEs.

Basque Country, Spain

4.14 The Basque Country is one of Spain's most prosperous and innovative regions.[37] It has a long industrial history, and today is renowned for its strengths in advanced machinery, as well as other key sectors such as energy, automotive, and electronics/ICT.[38] This case study has been informed by a review of online material, published academic articles, and an interview with a representative from AFM, the Spanish Association of Manufacturers of Machine Tools.

Historic context and growth of the cluster

4.15 Since the early 1990s, the Basque Country has been at the forefront of the design and implementation of cluster policy.[39] At the time, the region was facing a deep economic crisis and high levels of unemployment due to the international steel crisis and the opening of the Spanish economy after the end of the Franco regime in 1978. The devolved Basque government responded to this with a strategy to construct new competitive advantages, and was a pioneer of cluster policy.

[33] Ibid
[34] Euractive (2024) The German economy's rude awakening
[35] WZL (2021) Securing Future Competitiveness by Sustainable and Resilient Production
[36] Ibid
[37] Frick, S. (2023) Turnaround Cities: Spanish Case Study Insights from the Basque Country & Bilbao
[38] Invest in Spain (2020) The Basque Country, Key Industries
[39] Grupo Spri (2014) The evolution of Cluster policies in the Basque Country

Bilbao, Spain

4.16 However, the emergence of the Basque machine tool cluster began before the implementation of specific cluster policy[40], and followed five distinct stages:

- **Emergence (1914-1959):** Local producers were attracted into machine tool manufacturing due to a protectionist macro-industrial environment and high demand from Spanish industry. The growth was facilitated by the region's long-standing artisan culture and expertise in the iron and steel industries.
- **Growth phase (1960 to 1974):** Large scale creation of new businesses driven by local and global industrial expansion, supported by government investment in skills provision.
- **First stage of maturity (1975-1994):** The integration of Spain into the European Economic Community exposed local companies to more technologically advanced foreign competition. Joint public and private interventions were implemented in response, such as the creation of the IMG Training Institute. A period of rapid growth followed with c.140 companies and 8,000 employees by the late 1980s.
- **Renewal stage:** Aided by the implementation of cluster policy, the renewal stage from the mid-1990s is characterised by a growth of foreign sales and development of local innovation resources.
- **Second stage of maturity:** Today the cluster is considered to be mature, with a high concentration of activity in both terms of geographic proximity and the number of companies.[41]

[40] Zubiaurre, A., Sisti, E., Retegi, J. (2020) The integration of the Basque machine tool cluster into GVCs, Competitiveness Review, Vol. 30 No. 4, pp. 471-484

[41] Seclan, J., and Barrutia, J. (2018) Kibs and innovation in machine tool manufacturers. Evidence from the Basque Country. International Journal of Business Environment, Inderscience Enterprises Ltd, vol. 10(2), pages 112-131

Current activity in the cluster

4.17 Basque Country is the third largest producer of machine tools in the EU, and the 9th largest in the world.[42] There are different estimates on the total size of the cluster, but according to Eustat, the Basque Statistics Institute, the machine tool sector in the Basque Country had a turnover of €813 million and employed over 4,000 people in 2020.[43] It is the stronghold of national production, with the majority of Spanish machine tools being manufactured by the 128 companies located there.[44] [45]Many of these companies are SMEs, which account for over three quarters of the workforce in the sector.[46] That said, the cluster comprises a heterogenous collection of companies both in terms of specialisation and size. Companies supply a wide variety of sectors, including aerospace, automotive, railway, energy, and defence.[47] The area is particularly well known for its metal cutting machines. Figure 4-1 overleaf presents some of the key firms and innovation support organisations at each stage of the advanced machinery value chain.

Drilling on a lathe

[42] SPRI Group (2024) Main Industrial Sectors
[43] Eustat (2022) The Machine tool sector in the Basque Country
[44] SPRI Group (2024) Main Industrial Sectors
[45] According to one source it is over 90% of production (SPRI Group (2024) Main Industrial Sectors), whilst according to another it was around 53% (Eustat (2022) The Machine tool sector in the Basque Country)
[46] Ibid
[47] SPRI (2023) Basque Machine Tools Sector Overview

Figure 4-1: Value chain of industry in the Basque Country

Source: SPRI (2023) Basque Machine Tools Sector Overview, available to download: [Invest in Basque Country: advantages and advice – SPRI Group]

4.18 In addition to the industry base, the Basque Country has a number of anchor institutions and networks which have enabled the development of the machine tool cluster over the years. Key examples include:

- **AFM** is the Spanish Association of Manufacturers of Machine Tools. The organisation is based in San Sebastian and has 800 member organisations across Spain, many of which are located in Basque. Over the past 15 years, the association has been building an ecosystem around manufacturing, which has started with supporting the machine tool industry. Its focus on the Basque country is primarily due to the cluster policy mentioned above. AFM works to promote internationalisation and the technological innovation of its member companies. **INVEMA** is the Foundation for Machine Tool Research, and the technological unit of AFM; it does not conduct R&D but rather promotes and convenes activity amongst AFM members. Key activities include organising collaborative working groups focused on technical issues, convening joint participation in exhibitions and conferences, and organising meetings and events to disseminate information. This complements AFM's work on talent, marketing and exports.
- **IDEKO** is a research centre specialising in industrial production and manufacturing technologies. It is part of the Danobat group, one of the largest machine tool building groups in Spain. The activity undertaken by IDEKO includes: opportunity identification; design and development of products, business lines and production processes; and technical consultancy. The centre provides access to state of the art facilities and equipment, and is committed to collaborative work with industry and other research centres. It is part of the Basque Research and Technology Alliance, an agreement between 16 technology centres and cooperative research centres belonging to the Basque Network of Science, Technology and Innovation, the Basque Government, SPRI Group, and three local councils.
- **Tecnalia** is the largest centre of applied research and technological development in Spain. It is a national organisation with international reach, headquartered in Gipuzkoa in the Basque Country. The centre's research spans smart manufacturing (including manufacturing processes), digital transformation, energy transition, sustainable mobility, health and food, urban ecosystem,

and the circular economy. Across the whole of the organisation, Technalia employs over 1,500 people and works with over 9,800 companies.[48]

- **TKNIKA** is another Basque-based applied research centre, which focuses on innovation in technology, education and management. TKNIKA has run a number of projects to support Basque's machine tool cluster, including the Machine Tool Alliance for Skills project which aimed to "provide the industry with the entrepreneurial competences that emerging technologies will require".
- **IMH**, Institute of Machine Tools, is an advanced educational and training centre located in the Basque Country. It specialises in advanced and digital manufacturing, offering a range of programs including vocational training, dual engineering degrees, and continuing education

Key success factors

4.19 A number of factors have enabled the successful growth and development of the Basque machine tool cluster. On a practical level, this includes the **proximity of industry to key research institutes**. The Basque cluster is relatively concentrated, with most companies located within a 300km radius.[50] It is possible to reach most research institutes and training facilities in the region within a reasonably short journey, which enables collaboration and relationship building. Importantly, Basque is a stronghold of Spain's manufacturing industry meaning that **other parts of the value chain and key customers are co-located in the region**.

4.20 Partly enabled by the geographical proximity, the Basque cluster has **developed a strong culture of collaboration**. This is a core objective of the AFM, which establishes working groups to help industry overcome shared challenges. These working groups tackle key issues such as internationalisation, digitalisation, innovation and quality assurance. In establishing these working groups, AFM ensures that core members with experience of collaboration are included, to show how it can be done successfully. The cluster also benefits from extensive networking events and activities, many of which are organised by AFM.

[48] Technalia (2024) About Us
[49] Tknika (2016) Machine Tool Alliance for Skills
[50] SPRI Group (2024) Main Industrial Sectors

4.21 Another key success factor is the **strong supply of skills** to the cluster. The Basque Country has the highest concentration of engineering graduates of any European region (39.7 per 1,000 inhabitants).[51] The region's four universities produce over 350 mechanical engineer graduates per year, as well as 240 industrial engineers, 190 electronics engineers and 170 computer engineers.[52] Central to the cluster's skills supply is the Machine Tool Institute (IMH), which offers specialised training in advanced manufacturing and technological/organisational innovation. The IMH is funded by the Basque government, and is considered an "integral part" of the machine tool cluster.[53]

4.22 The cluster has benefitted from a **high level of support from the Basque government**. As highlighted above, public sector support from the cluster has been long-standing, notably starting with the cluster policies implemented in the 1990s. For example, the Basque government Department of Industry, Innovation, Trade and Tourism established Strategic Sector Observatories to identify the knowledge needs of Basque companies. These observatories facilitate access to strategic information for Basque's priority clusters.[54] Furthermore, the Basque government provides funding for key actors in the cluster, such as AFM and the IMH. Importantly, technological policies are designed with **joint participation of the companies, and public and private technological entities of Spain and Europe**[55].

Engineer adjusting grippers on a robot

4.23 Finally, the cluster has benefitted from a **strong internationalisation** plan, achieving exports of c.€655 million in 2021.[56] Key markets include the USA, Germany, Italy, China, France, Turkey and India.[57] Across these markets, there are three key product groups which are: parts and accessories for machine tools; lathes and turning centres for removing metal; and machine tools for drilling, boring, milling or threading metals other than lathes.[58] This level of

[51] SPRI (2023) Basque Machine Tools Sector Overview
[52] Ibid
[53] TKGUNE (2022) IMH Campus
[54] Bizkaia Talent (Undated) Basque Country
[55] Valdivieso (2004) From Boundaries in the Technological Innovation Chain: The Machine-Tool Industry in the Basque Country, Management Research, Vol. 2 No. 1, pp. 49-64.
[56] Eustat (2022) The Machine tool sector in the Basque Country
[57] Ibid
[58] Ibid

internationalisation means the cluster is more resilient to local economic shocks.

Key challenges

4.24 The key challenge for the Basque cluster is the **limited number of large end-users (buyers) in the region**. As highlighted above, most machine tools are exported. This means that Basque companies face a challenge with developing relationships with foreign buyers and remaining competitive on an international scale (especially against large producers in China). Indeed, the advent of new competitors has resulted in a decrease in the Basque country's global market share.[59] To overcome this challenge, the AFM has organised working groups focused on internationalisation. AFM also co-ordinates promotional activities overseas, supports overseas visits, and provides advisory services for companies seeking to internationalise. At an individual level, Basque companies are aiming to remain internationally competitive by offering customised solutions and maintaining flexibility in their production processes. This allows them to meet specific customer needs, adapt to changing demands, and appeal to a wider market. Furthermore, they are enhancing their post-sale services.

NGen, Canada

4.25 NGen is an industry-led, non-profit organisation leading Canada's Global Innovation Cluster for Advanced Manufacturing – one of five national networks supported by Canada's ambitious Global Innovation Clusters Initiative.[60] Established in 2018, these Global Innovation Clusters are designed to accelerate growth by building connections, linking SMEs to larger firms, increasing investment in innovation, and maximising IP creation.[61] NGen seeks to:

- support development of world-leading advanced manufacturing capabilities in Canada
- promote development, deployment and adoption of cutting-edge technologies
- facilitate the pursuit of operational excellence for Canadian companies.

[59] Seclan, J., and Barrutia, J. (2018) Kibs and innovation in machine tool manufacturers. Evidence from the Basque Country. International Journal of Business Environment, Inderscience Enterprises Ltd, vol. 10(2), pages 112-131

[60] NGen: Next Generation Manufacturing Canada, Government of Canada (2024) Global Innovation Clusters

[61] Ernst & Young (2022) Innovation Superclusters Initiative: Economic Analysis

4.26 NGen's focus on advanced manufacturing as a whole is broader than that proposed for AMPI, but the NGen model has similarities for the AMPI proposals. This case study has been informed by documents and resources published by NGen, supplemented by evidence relating to the wider Global Innovation Cluster programme.

Current activity in the cluster

4.27 Linking SMEs to larger advanced manufacturing organisations is central to NGen's activity. To deliver this, NGen operates a free membership model, inviting organisations and experts to support collaborative advanced manufacturing projects. As of March 2024, the network had 9,700 members (c.3,500 corporate members and c.6,200 individual experts and researchers) across Canada. It also has links internationally, with approximately 250 members based outside Canada.

4.28 NGen does not charge a fee for membership in an effort to engage as many organisations as possible. Members are eligible to apply for Technology Leadership projects (detailed below), receive news and updates from NGen, and publish information about their advanced manufacturing capabilities on NGen's digital collaboration platform.

4.29 Over its first five years of operation, NGen received c$50 million (c.£27 million) per year as core grant from the Canadian Government, falling to c.$30 million (c.£16 million) per year for the subsequent six year period. For the period 2018-2028 overall, NGen will receive c.$460 million (c.£250 million), almost all of which is publicly funded. In addition to direct funding, NGen has also leveraged an additional $444 million (£244 million) in project contributions from industry to date.

4.30 NGen's two main activities are: Technology Leadership projects; and Strategic Ecosystem initiatives.

Technology leadership projects

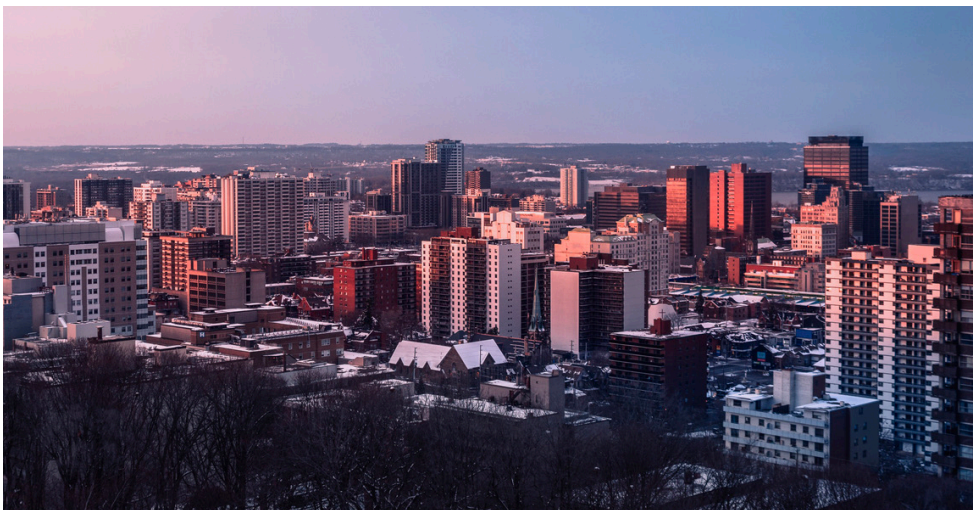
4.31 Technology Leadership projects are designed to be flexible to industry challenges and needs, and are therefore diverse in nature. All involve collaborative R&D activities between industry (including SMEs) and academia to develop

manufacturing solutions which can be adopted at scale by manufacturers. These projects typically involve 3-6 partners, receive between $1 million – $3 million (£600,000 – £1.7 million) in NGen investment, last for 2-3 years and leverage an average 1.7x of public investment in industry contributions.[62]

4.32 All projects must meet strategic eligibility criteria established by NGen's Board of Directors:

- **Transformative** – building world-leading advanced manufacturing capabilities that enhance the competitiveness of Canada's advanced manufacturing ecosystem.
- **Applied** – supporting the development, scaleup, and adoption of advanced manufacturing solutions with significant near-term commercial potential.
- **Collaborative** – enabling capabilities that no individual company can achieve on its own.
- **Enduring** – contributing know-how and resources that strengthen Canada's advanced manufacturing ecosystem.

4.33 By the end of March 2024, NGen had approved investments of $292 million (£161 million) in 210 Technology Leadership projects with total innovation investments expected to reach $736 million (£405 million, including industry contributions). Those projects have involved 483 industry partners – 88% of which are SMEs – and 313 academic and other research partners.



Hamilton, Canada

[62] See Annex 2 in the 2023/24 Annual Report for a full breakdown of Technology Leadership projects

4.34 Going forward, NGen will target investments over the next five years to support industry-led collaborative Technology Leadership projects in the following priority areas: the Electric Vehicle Value Chain; Industrial Decarbonisation and the Circular Manufacturing of Materials; adoption of AI solutions by Canadian manufacturers; Quantum solutions for manufacturing; and the Moonshot for Mining, Minerals, and Manufacturing (M4M3) initiative; and other transformative Advanced Manufacturing solutions in fields like aerospace, electronics, advanced construction systems, biomanufacturing, medical devices, robotics, and customised automation systems.

Strategic Ecosystem initiatives

4.35 NGen has invested in a variety of Strategic Ecosystem initiatives which have:

- Strengthened collaboration among 24 advanced manufacturing clusters across Canada.
- Provided transformation management and skills development support to over 3,300 manufacturing workers across the country.
- Provided manufacturing entrepreneurship and financial literacy education to c.570 Indigenous students in 17 elementary and secondary schools in northern Canada.

4.36 Looking forward, NGen has allocated $26 million (£14 million) to support Strategic Ecosystem initiatives between 2023-2028. These initiatives seek to facilitate the commercialisation of advanced manufacturing solutions, develop strategic opportunity roadmaps for the industry, as well as enhance connections and collaboration across Canada's advanced manufacturing ecosystem.

4.37 Advanced Manufacturing cluster bodies in Canada are typically defined by their sub-sector (such as Bioindustrial Innovation Canada), and are often nationwide, although are sometimes geographically concentrated (for example Wood Manufacturing Cluster of Ontario). As part of its Strategic Ecosystem initiatives, NGen has established a Cluster Accelerator programme with funding allocated to help strengthen collaboration.[63] This initiative provides up to $100,000 (£55,000) per year per cluster body, for two types of projects:

[63] NGen (2024) Cluster Accelerator Network

- **Cluster start-up interventions** designed to support the development of new advanced manufacturing cluster bodies with a shared goal to drive innovation and business growth within a collaborative framework. Each cluster body must have recruited at least five member companies and developed a plan for sustainable operations.
- **Cluster building initiatives** are much more diverse, depending on the needs and ambitions of existing clusters. Examples of projects include:
  - **Innovation projects, to promote the development and/or adoption of advanced manufacturing technologies by funding collaborative activities.**
  - **Commercialisation projects, to scope out strategic opportunities for supplier and business development, support commercialisation and export readiness of cluster members, and/or facilitate participation in international export or investment missions.**
  - **Sustainability projects, to assist cluster members in improving environmental management, reducing GHG emissions, and/or strengthening domestic supply chain resilience.**
  - **Workforce and Management Enhanced projects, to enhance the innovation management capabilities of its members, attract young people and underrepresented groups into careers in advanced manufacturing.**
  - **Networking projects, to support collaborative initiatives among two or more clusters in pursuit of innovation, commercialisation, sustainability, or workforce and management enhancement objectives.**

Key success factors

4.38 An evaluation of the International Supercluster Initiative (ISI, which provided the initial funding for NGen) identified various key success factors[64] including:

- **The role that members played in shaping the delivery model** by providing feedback to Superclusters on operation and management, so ensuring the initiative was industry-led.
- **Collaboration (facilitated through Technology Leadership projects and Strategic Ecosystem initiatives) was identified as key to the success of the programme**,

[64] Innovation, Science and Economic Development Canada (2022) Evaluation of ISED Canada's Innovation Superclusters Initiative

as it leads to the participation of more companies, and generates better results from more perspectives in projects. Allowing funding to be accessible to companies of all sizes has helped SMEs to participate.

- Project participants had positive perceptions of the delivery model, with **the funding application process being straightforward and quick** compared to other programmes. The oversight and approval processes were seen to show good stewardship of taxpayer funds while not being onerous for participants.
- **The industry-led approach was found to be a key strength in allowing the Superclusters to effectively respond to identified and emerging industry priorities**. Industry's active involvement in programme decision-making and project selection ensures commercially relevant projects receive funding.

Key challenges

4.39 A separate report identifies a number of common challenges in the establishment of NGen and other Superclusters:[65]

- **Governance:** Balancing the need to have robust governance structures whilst avoiding long, complex negotiations about what exact form the governance structures should take and which organisations/individuals should be represented.

Gear cutting lathe

- **Time to first projects:** Balancing the pressure to deliver 'quick win' projects against the need to build relationships and capacity across the ecosystem and select projects aligned to long-term strategic objectives.
- **Process innovation versus transformation:** Balancing providing support for large R&D projects with potentially significant, transformational impacts, with supporting smaller projects that are process innovations and part of an iterative R&D process which may ultimately lead to significant innovation benefits. The report suggests that it has been easier to undertake smaller projects at the outset of the Supercluster initiatives.

[65] Brookfield Institute for Innovation and Entrepreneurship (2021) Building Superclusters for Canada

- **New supply chain linkages:** Each Supercluster found challenges in building new supply chain relationships. Large industrial players in Canada have a track record of adopting technologies from proven solutions, often from foreign technology companies, especially those in the U.S. Given their size and requirements for sign-off from headquarters, they are often slow to adapt and change. At the same time, SMEs are more agile, but typically have limited capacity to create and adopt new technologies in a way that allows participation in global supply chains with large anchor firms.
- **Regional versus national superclusters:** Each Supercluster has a geographic concentration (for NGen, this is in Ontario). While proximity and density are important for a strong ecosystem, each Supercluster has been challenged to develop a national reach. However, questions remain concerning the right balance of activities in this respect. A separate study on the Supercluster initiative suggests that, while geographical proximity may be an advantage for facilitating collaboration, it is neither sufficient nor necessary for successful collaboration.[66] Instead, collaboration can be facilitated by temporary proximity (for example multi-day, face-to-face visits), cognitive proximity (the extent to which collaborators share a common knowledge base), and/or social proximity (the strength of trust relations between stakeholders).

Implications for AMPI

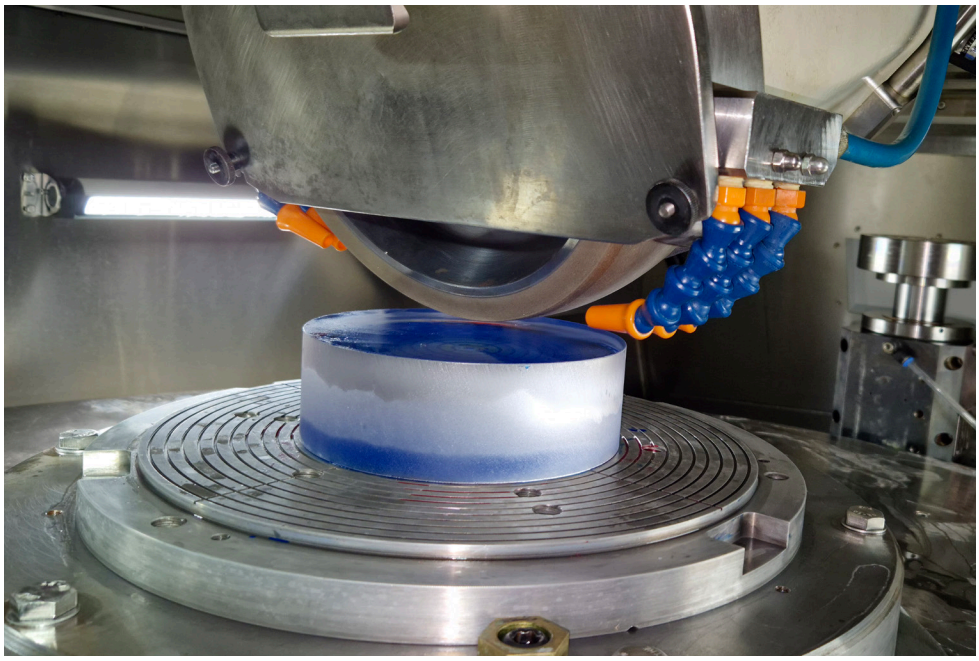
4.40 The three case studies present the following implications for AMPI:

- **Sustained public sector funding (at scale) will be required.** In all three cases, a strong legacy of and/or commitment to the advanced machinery and broader manufacturing sector has been critical to their success. Moreover, this support needs to span a number of different public funding bodies and departments. For example, the Aachen advanced machinery cluster has benefitted from investment from federal and state governments, while NGen has received support from central government as well as public bodies such as the Canadian Space Agency, and the National Research Council.

[66] Beaudry, Catherine, and Laurence Solar-Pelletier. 2020. The Superclusters Initiative: An Opportunity to Reinforce Innovation Ecosystems. IRPP Study 79. Montreal: Institute for research on Public Policy.

- **It takes time to establish successful clusters** – NGen is still in its early stages compared to cluster policy in the Basque country since the early 1990s – and previously disparate actors may require encouragement to build collaborative relationships.
- **Initiatives should be industry-led rather than research-driven.** To deliver commercial benefit to businesses, projects funded by AMPI should seek to address pressing industrial challenges which are preventing growth. To ensure alignment, there is a need for frequent and open dialogue between AMPI and the UK advanced machinery and wider manufacturing sector. There may be opportunities for AMPI to achieve this through governance (by establishing a Board of Directors including industry leaders and experts) and through the activity it funds, by establishing competitions which are flexible to the needs of businesses.
- **Importance of facilitating SME involvement,** both in cluster organisations and R&D activities. In order for AMPI to be truly representative of the sector, it needs to engage with a diverse range of businesses and organisations which contribute towards the UK's advanced manufacturing sector. Not only will this aid AMPI to deliver on challenges relevant to smaller businesses, greater participation of SMEs in supply chains will promote scale-up and facilitate technology spillovers across the wider sector.
- **Overcoming geographical barriers to collaboration.** Both clusters in the Basque Country and Aachen demonstrate how a close proximity of advanced manufacturing businesses and research institutes have contributed to strong collaboration and levels of trust between partners. However, NGen in Canada demonstrates how geographical proximity is not a requirement for successful collaboration. Instead, collaboration can be facilitated by temporary proximity (for example multi-day, face-to-face visits), cognitive proximity (the extent to which collaborators share a common knowledge base), and/or social proximity (the strength of trust relations between stakeholders).
- **AMPI should be outward looking and seek to promote the UK on a global stage.** This may involve activities relating to improving exports, seeking to build and enhance global supply chains. An important element to this relates to showcasing, either through hosting events

(for example AWK provides Aachen-based SMEs with opportunities to demonstrate their innovations, network with global industry leaders) as well as representation at global advanced manufacturing conferences (such as Canada's selection as the partner country for Hannover Messe 2025).



Grinding head on a Fives Landis optical grinding machine

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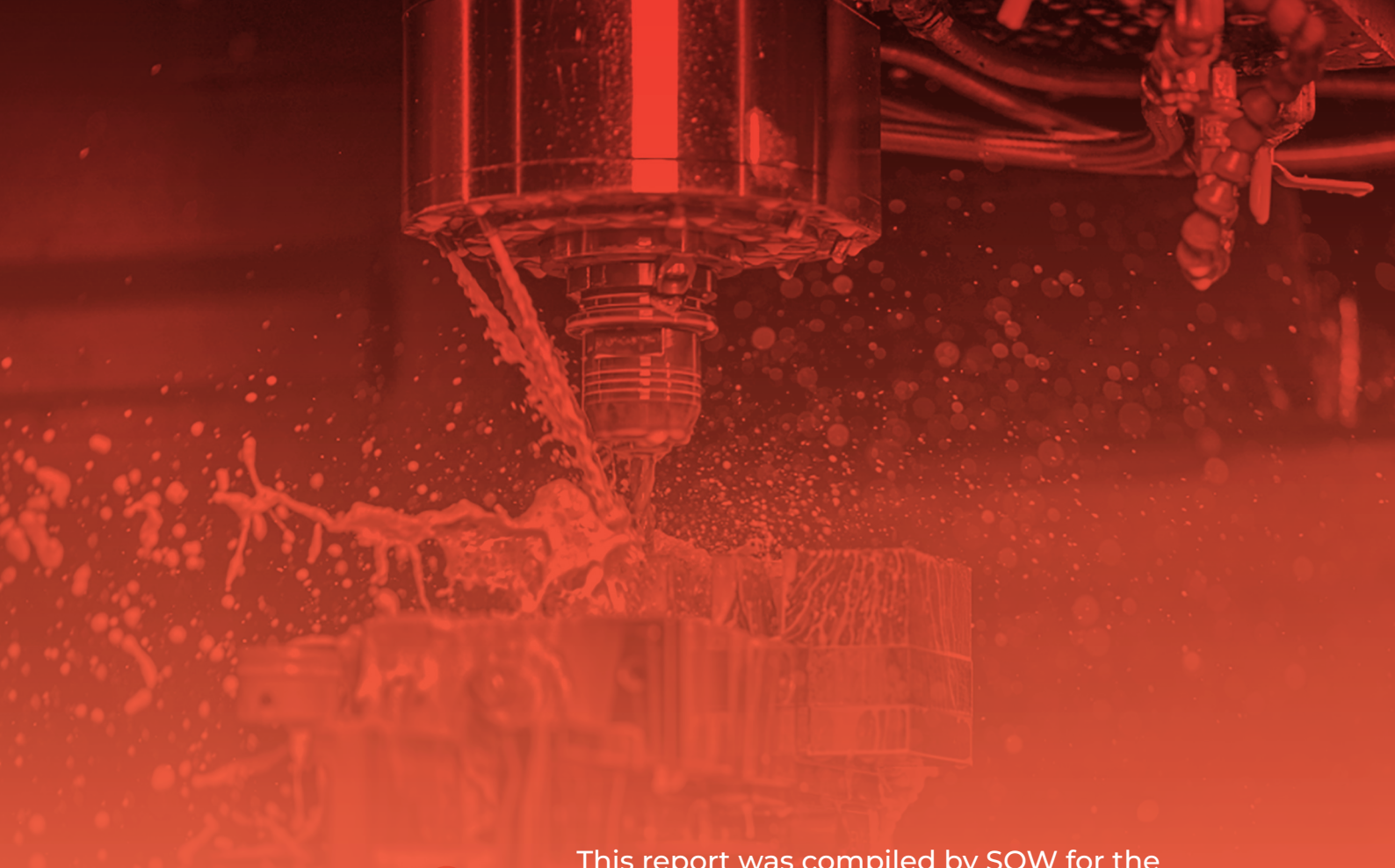

This report was compiled by SQW for the AMPI SIPF Programme.

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