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Enabling Skills for the Industrial Decarbonisation Supply Chain

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UK Research and Innovation

This work was supported by the UKRI ISCF Industrial Challenge, through the UK Industrial Decarbonisation Research and Innovation Centre (IDRIC) award number: EP/V027050/1, under the Industrial Decarbonisation Challenge (IDC).

This report is an output from IDRIC project 9.5 ‘Enabling skills for the industrial decarbonisation supply chain’

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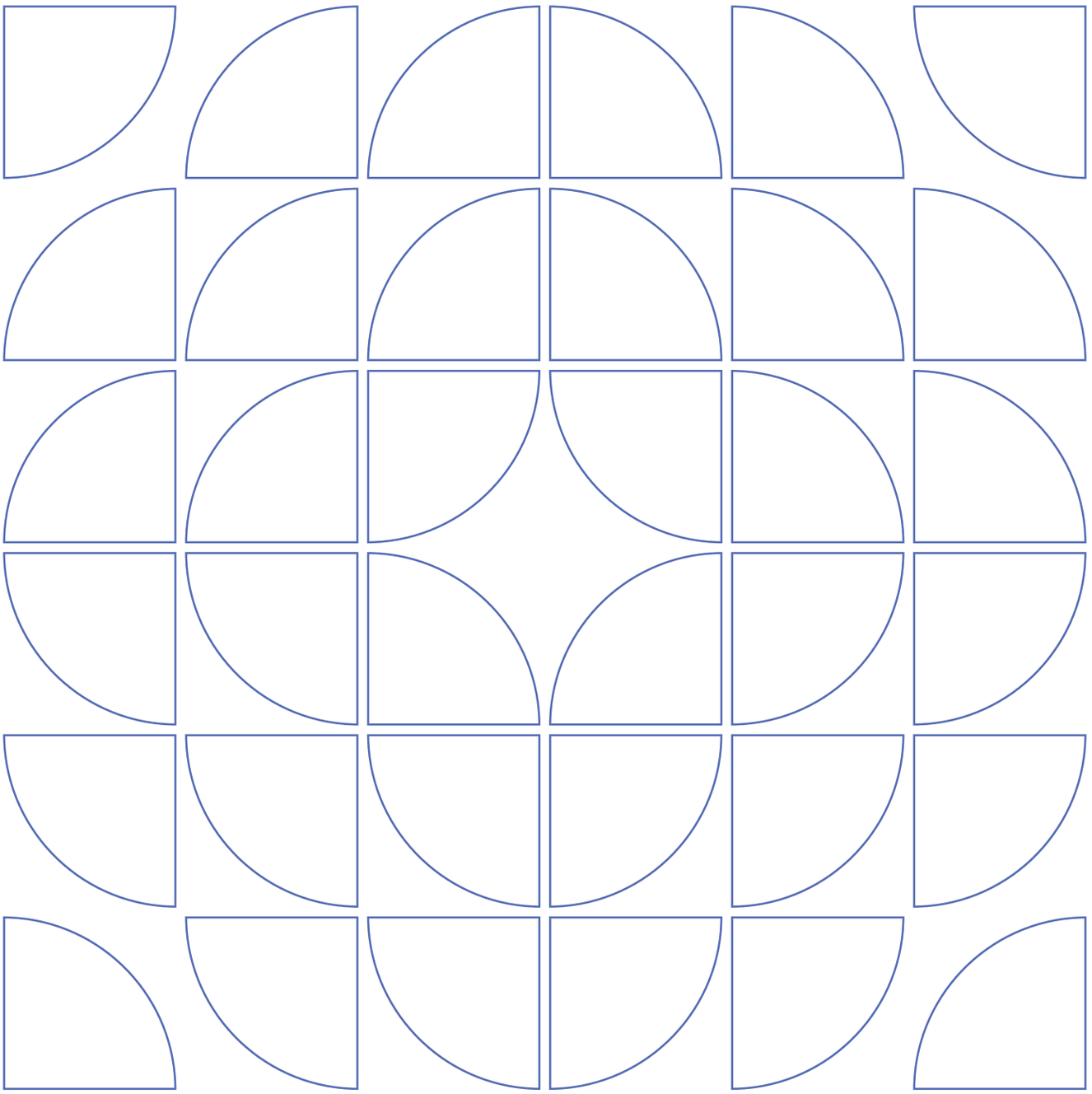


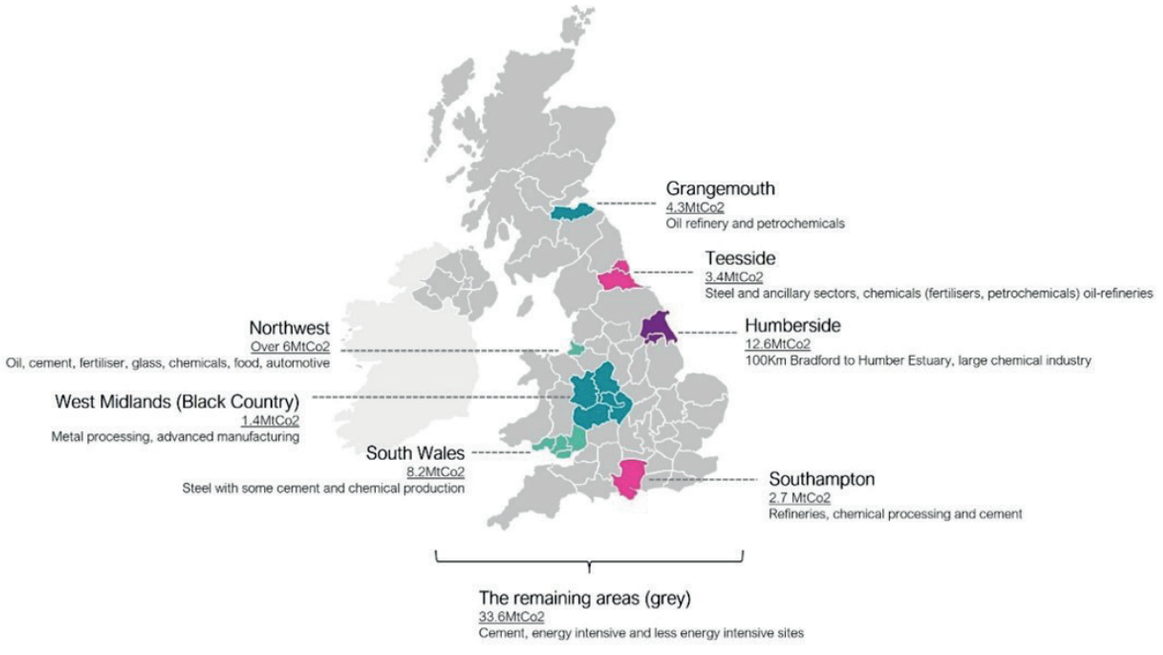
Executive summary

One may argue that the UK, in at least nominal terms, is a relatively small contributor to global CO2 emissions and thus downplay its impact, however, throughout history the UK has made a disproportionate contribution to the accumulation of greenhouse gasses. As such the UK has committed to investing in the people, innovation, technologies, and infrastructure to play its part and to reach its decarbonisation goals by 2050. By doing so, the UK, on a global scale, will be competitively placed at the forefront of innovation to rebuild and grow industrial capabilities through new green initiatives and the development of a skilled workforce. The UK can shape this fourth Industrial revolution through the intersection of technological, social, economic, and environmental drivers; key to maximising potential is a skilled workforce which will unlock the value that the transition to a net zero economy will bring.

The University of Chester (UoC), as part of the Industrial Decarbonisation Research and Innovation Centre (IDRIC), has appointed Mace for the provision of the Enabling Skills for the Industrial Decarbonisation Supply Chain (ESIDS) report. This document provides the recognised industrial clusters with details of the various roles that industry and supply chains will need to deliver, and accelerate, the industrial decarbonisation propositions outlined in the UK Industrial Decarbonisation Strategy.

The Department for Business, Energy, and Industrial Strategy (BEIS) has identified 7 key industrial clusters across the UK, each of which has their own characteristics and challenges. These clusters have been further refined by Government into Track 1 and Track 2 clusters. The Track 1 clusters are the North West and the east coast clusters of Teesside and Humber, whilst potential Track 2 clusters are South Wales, Southampton, Black Country and Grangemouth. See Figure 1 below.

Figure 1: Industrial Clusters as per UK Industrial Decarbonisation Strategy, 2021



The UK has experienced significant industrial decline, often concentrated in the areas now identified as the industrial clusters, which has led to high levels of unemployment and deprivation.This has been further exacerbated as those with skills have moved away to seek work elsewhere.This is particularly acute in the North West, Teesside and Black Country clusters which have been identified as being in the top 10% of the Indices of Multiple Deprivation (2019) with respect to employment. The Skills for Jobs – Lifelong Learning for Opportunity and Growth initiative sets out how the UK will reform education to support people in developing the skills needed regardless of background or location to support growth areas such as decarbonisation and as such, the decarbonisation agenda offers opportunity to effect real change in learning, training, and employment opportunities.

As with other developed nations, the UK is facing the challenges of an ageing population. Furthermore, structural changes to the economy and the decline in those with the skills needed to support industry has led to an ever-widening skills gap across all areas of the economy. This could be perceived as a crisis rather than a gap and the UK must adapt both learning and working practices to manage the predicted shortages in both skills and labour. The demographic trends and inequalities evident in the clusters will inform how to address the challenge of levelling up; industrial decarbonisation represents a significant economic opportunity as industry adapts to support the change. The demand created will create challenges for the economy as it deals with the structural, cyclical and adjustment challenges anticipated. Early intervention is needed to help address these challenges and facilitate the economic adjustment needed.

The expected economic demand resulting from decarbonisation developing as an industry is likely to result in some non-decarbonisation projects being “crowded out” due to the limited supply of available resources focusing on areas where rewards are greatest. To estimate the size of the economic opportunity that decarbonising UK industry represents we use scope 1 emissions data, as provided by the National Atmospheric Emissions Inventory (NAEI) as a proxy for scale. We have derived the CAPEX, see Table 1 below, required across all decarbonisation activities.

Table 1: Summary of estimated CAPEX to 2050

Industrial Cluster	Emissions $MtCO_2$ (NAEI 2019)	£bn
North West	2.1	31.8
East Coast - Humber	5.4	46
East Coast - Teesside	1.3	30
Grangemouth	1.5	35
South Wales	2.7	24.3
Southampton	1.4	16.5
Black Country	0.1	2
Total Cluster shared & deployment infrastructure	14.5	185.6
Dispersed shared & deployment infrastructure	22.6	286.2
Total UK deployment infrastructure	37.1	471.8
Total Sector Sites		43.2
Total UK		**515.0**

CAPEX £515bn to 2050

The Track 1 clusters will initially lead the way with carbon capture, utilisation, and storage (CCUS) infrastructure, though critical to a successful decarbonisation programme is knowledge exchange between all the clusters, particularly around physical infrastructure needs. Alongside this, identification and development of the skills needed to support the decarbonisation agenda is equally critical.

To establish which skills will be needed to decarbonise UK industry, we need to understand and quantify the programmes, projects and infrastructure needed to achieve decarbonisation. To do this, the study considers three separate aspects as follows:• Strong cluster leadership is a key element of success, but there is no ideal form of cluster governance. Configurations and membership vary according to country, technology field, local context, age of the cluster and cluster focus.

- Industrial clusters shared benefit and deployment infrastructure;
- Dispersed industrial areas outside of the industrial clusters;
- Industrial sites in multiple sectors located with the clusters and dispersed across the UK.

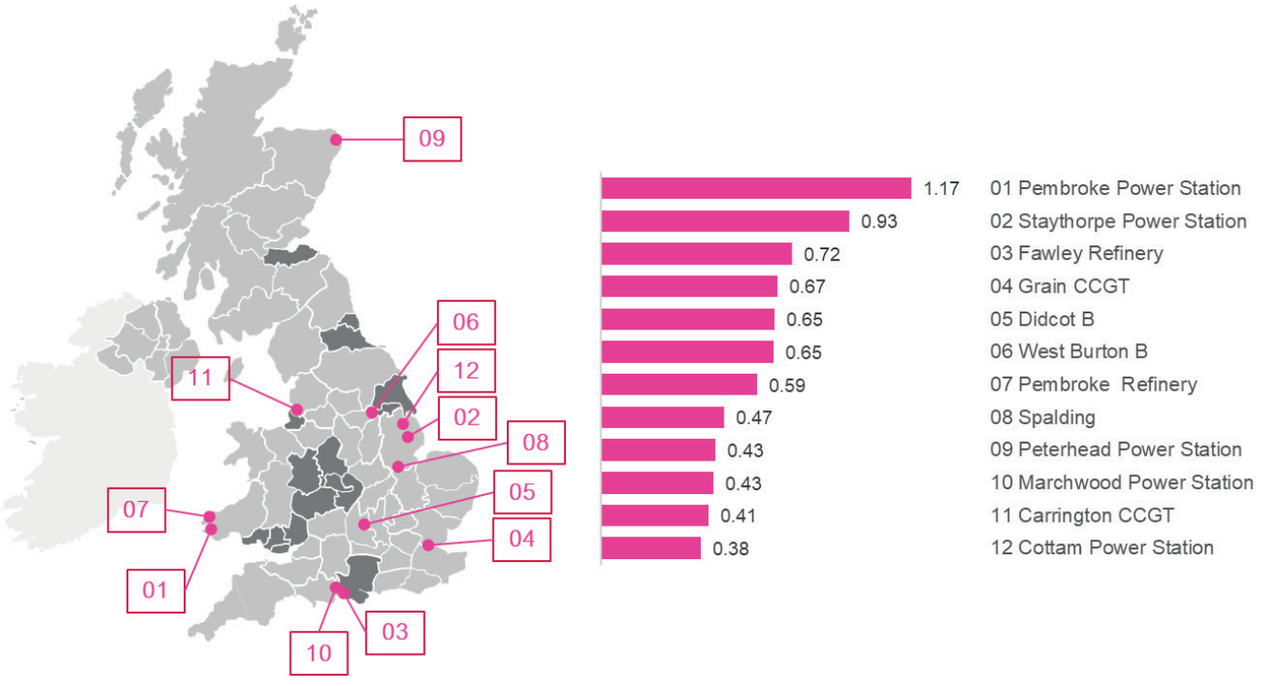
Using the UK Industrial Decarbonisation Strategy as a guide, as well as direct engagement with the clusters themselves, we estimate CAPEX in the magnitude of £515bn will be needed for the decarbonisation programme to 2050, see Table 1 above. Cluster projects cannot be delivered as standalone projects but must form part of the wider decarbonisation programme already commencing in some clusters. The projects needed to deliver industrial decarbonisation can best be grouped around the following technologies and infrastructure as set out in Table 2 below:

		CCUS / CCS	Heat Exchange / Heat Pumps	Hydrogen Fuel Switching	BECCS	Circular Economy	Transport of CO_2 by Ship	Zero Carbon Electrification	Smart Technologies	Scope 1 Energy Efficiency	District Heating	Fuel Switching to Hydrogen	Industrial CCUS- Enabled H_2	Industrial Electrolytic H_2	Industrial CCUS Fossil Fuel
Track 1	North West	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	East Coast - Humber	■	■	■	■	■		■	■	■	■	■	■	■	■
	East Coast - Teesside	■	■	■	■	■		■	■	■	■	■	■	■	■
Potential track 2	South Wales		■			■	■	■	■	■	■	■		■	■
	Southampton		■			■	■	■	■	■	■		■	■	
	Black Country		■			■		■	■	■	■				
	Grangemouth	■	■		■	■		■	■	■	■	■	■	■	

The UK's core strategy is centred around the industrial clusters however many industrial sites fall outside the clusters, dispersed across the country. This includes energy intensive processes such as cement production, glass manufacturing and lime and most notably power producers that contribute the highest proportion of CO2 of all the industrial sectors, see Figure 2 below. Emissions reductions in dispersed sites will be largely driven by energy efficiency, electrification, and heat pumps in the 2020's.

Only once fuel switching systems (pipeline and CCUS networks) are fully evolved and the associated costs reduced, will they be able to reach these dispersed sites, making many of these sites more difficult to decarbonise due to the unavailability of this enabling infrastructure, expected to be realised in the 2030's onwards. The challenge of decarbonising power producers across dispersed vs cluster power sites stems from the CCUS / H2 enabling infrastructure required to decarbonise conventional CCGT producers.

Figure 2: UK Top Emitting Power Producers



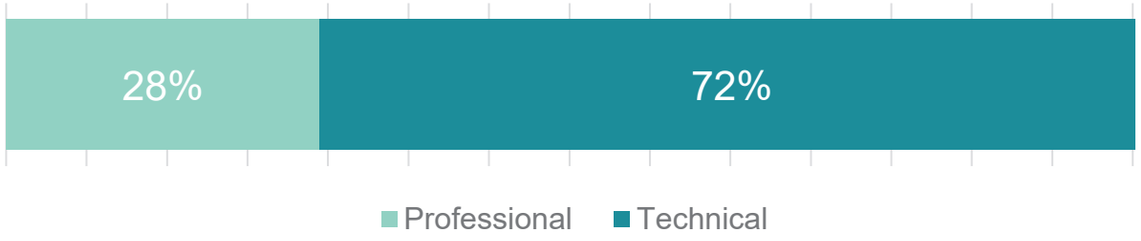
Initial efforts are rightly focused on deployment and shared benefit infrastructure critical in enabling industries to transition to net zero. In addition to major and minor power producers that account for significant CO2 emissions, and some industries that make up the tail end of industrial emissions, the key industrial sectors can be grouped as follows:

- Chemical
- Cement
- Iron & Steel
- Food, Drink & Tobacco
- Other Mineral Industries
- Oil & Gas
- Paper, Printing & Publishing

Profiles of each of these sectors, each with unique challenges with respect to decarbonisation, has informed a respective cost per ton of CO2 abated, thus completing CAPEX calculation to achieve Net Zero by 2050 (Sector Sites in Table 1). To deliver this c. £515bn of infrastructure and decarbonise industry by 2050, a workforce of c. 350,000 additional people across the three stages of preconstruction, construction, and operation will be needed, see Figure 3 below. Both technical and professional roles are required, with a bias to technical people delivering on site, see Figure 4 below. Although some of this demand will be for more generalist skills and competencies such as accounting, marketing, and administration etc, most will be design, engineering, manufacturing, and construction.

Figure 3: Estimated jobs needed to deliver industrial decarbonisation based on estimated CAPEX

Figure 4: Estimated proportion of professional to technical jobs needed



This scale of demand for construction workers and civil engineers represents a significant challenge, given the current labour market tightness in the UK economy generally and in construction and civil engineering especially. There are currently insufficient workers in the sector to meet this extra demand, which unless acted upon through labour supply measures to increase the supply of workers and their skills, will harm the prospects for decarbonisation and for the UK economy.

Though the technologies to realise a Net Zero future are not yet all fully developed, the ongoing research, development, and innovation are critical to success: the key technologies available now to deploy, including amongst others CCUS and replacing natural gas with hydrogen, draw on the same skills and competencies used to deliver large scale industrial infrastructure today. The workforce in the existing oil and gas and energy sectors will likely find themselves well placed to be part of the transition to a decarbonised UK. Likewise, for the construction industry, the skills exist to build what is needed, the challenge being the competition for professionals and workers in a constrained labour market.

Of the approximately 32 million UK workforce c. 9 million are in occupations that may support industrial decarbonisation however this workforce is under pressure to deliver existing projects across multiple sectors. There is c. 1 million people in Higher Education (HE) (HESA, 2022), Further Education (FE) and apprenticeships (Office for National Statistics, 2022) in courses that may support industrial decarbonisation. See Figures 5, 6 and 7 below.

Figure 5: Current workforce that may support industrial decarbonisation, FE and HE students and apprenticeships

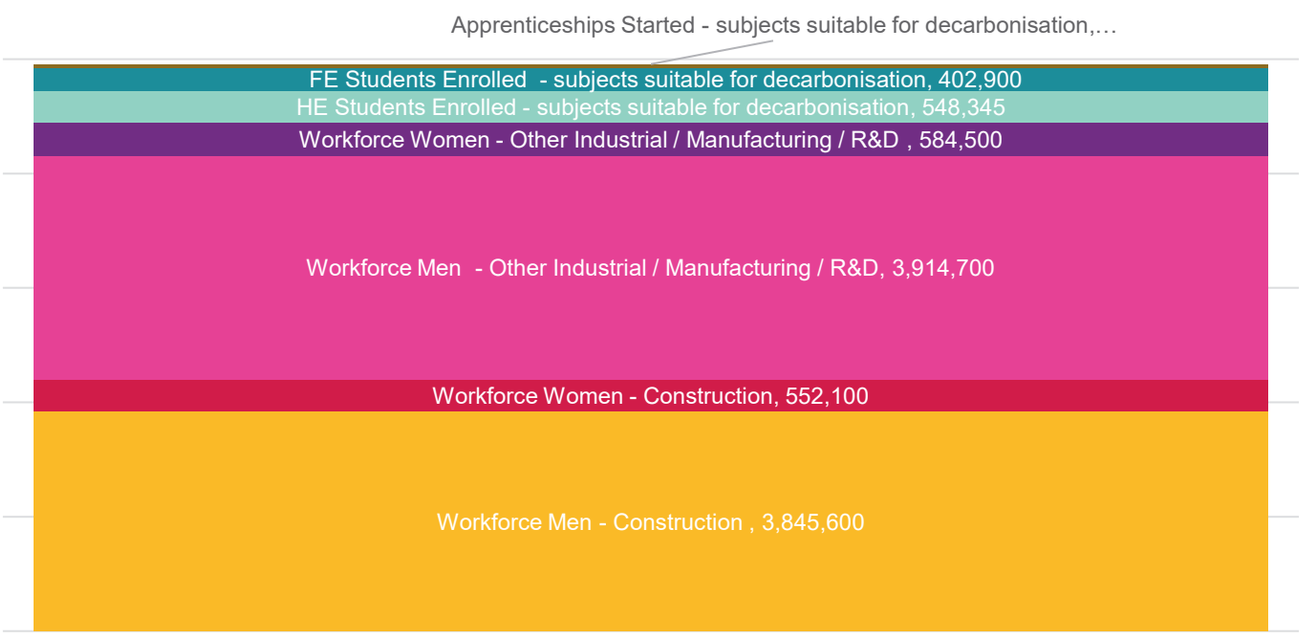


Figure 6: Number of Higher Education and Further Education Institutions by Region

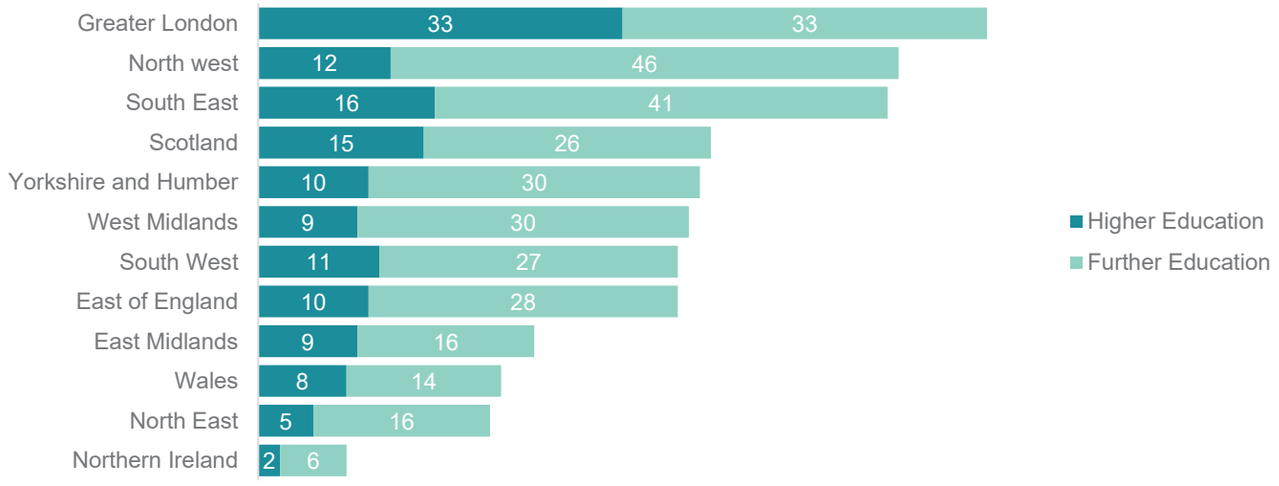
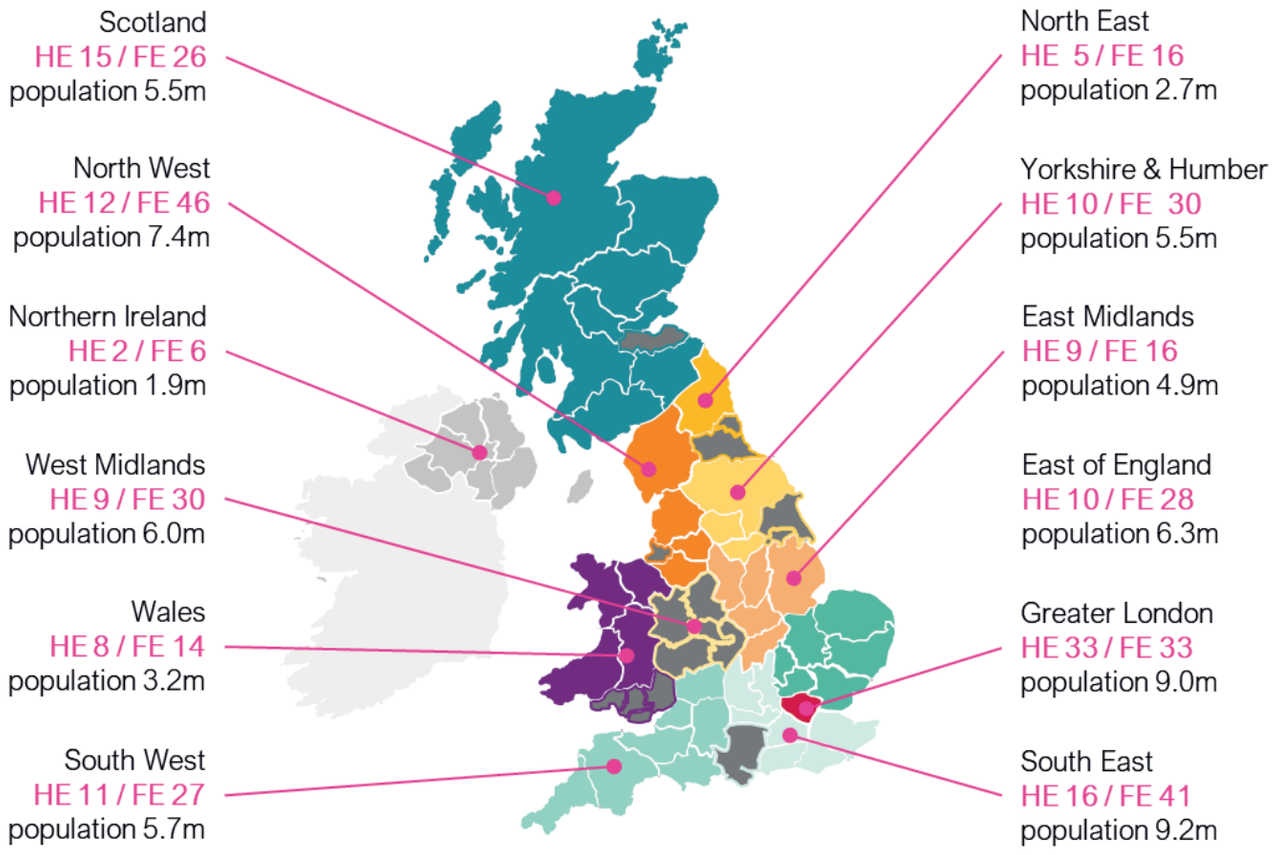


Figure 7: Geographical location of Higher Education and Further Education Institutions



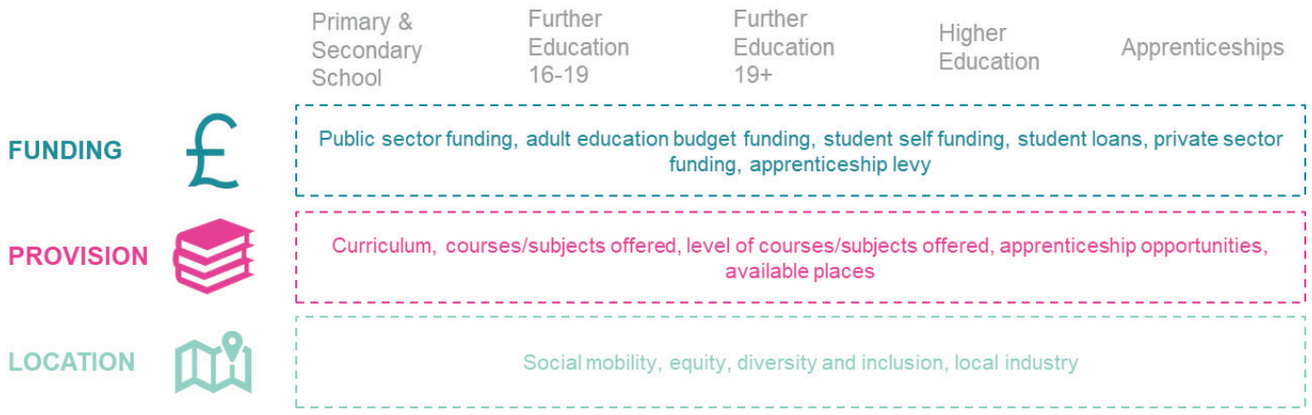
According to the Local Authority of Building and Maintenance (January, 2022), the demand for STEM (science, technology, engineering, and mathematics; and any subject or discipline that falls under these) skilled employees by the UK market, and moreover by the decarbonisation industry, is high due to:

- The UK's shortage of international STEM skilled talent exacerbated by Brexit;
- The limited supply of STEM educated and trained talent through higher education;
- The increasing demand for STEM skilled talent from several traditional and newly created industries, leading to an increased competition of talent attraction between them;
- The diverse range of new specialisations (technical and non-technical) blooming out of this large area of science;
- An ageing workforce of thousands of STEM skilled technicians, researchers, academics, and professional engineers reaching the point when they will need to be replaced in the next decade.

A substantial workforce is required to deliver industrial decarbonisation at the scale and timeline proposed by the UK Government. There are numerous options as to how to achieve effective workforce capability and capacity. As employers and industries begin to recognise their agediverse workforces, they must seek to understand how older employees can be reskilled to fulfil roles as well as appropriately skilling younger generations. The commonality between the two is the need for effective education and skills training, be it through practical experience, further education, or a hybrid approach.

It is proposed that a skills delivery plan will require, at its centre, an ESIDS National Delivery Board. This governance structure is the conduit for the UK Government and their respective industrial decarbonisation strategy, industry, the supply chain, research and innovation programmes and educational institutions down to the regional governance structures. It is vital that strategy, policy, legislation, the public and the private sector align to support necessary reforms to skills development at both a national and regional level. Three components to education in the UK that cut across each stage of the skills development system: funding (individuals and institutions), provision (available places and courses), and the location of educational facilities. Viewing education provision through this lens is helpful in identifying and organising necessary changes for each stage, see Figure 8 below.

Figure 8: Funding, provision, and location across stages of education



The UK has all the component parts within the education system to deliver industrial decarbonisation within the necessary timelines however some significant interventions and investment will be necessary from early development in primary school though to highly specialist tertiary education. These interventions should not only seek to increase the number of people within the UK's engineering and construction sectors to meet demand but, as importantly, significantly improve the diversity and inclusion within this area of the economy (see Figure 5). A diverse workforce that is inclusive will not only support social mobility within the communities that most need it but also enable more innovative industries.

These changes need to begin in primary and secondary school, where the messaging around gender and the stereotypes related to acceptable activities / occupations needs to be managed and a better understanding of available career pathways communicated. Concepts relating to climate change and the environment need to be embedded into the curriculum, and for those pursuing STEM subjects, it is important that an understanding of the HE/FE opportunities and potential careers is clear as this is a critical time with respect to choosing future pathways. Though not a new challenge, efforts to build the esteem of a technical pathway needs to be accelerated, with pupils counselled to align their ambitions, interests, and abilities to the best educational or vocational route for them.

For 16-to-19-year old's, FE is an important bridge to further tertiary education whether that is continuing with FE, pursuing HE studies or starting an apprenticeship. For this cohort, FE is fully government funded with the primary options being A Levels or more technical options through University Technical Colleges (UTC) as well as recently developed T-Levels. These options all have a role to play and it is important that public funding is reviewed to be equitable and allocated to best prepare a wide range of pupils. As with earlier education, the curriculum should reflect the challenges of climate change as well as creating meaningful opportunities to connect with industry both during and post-study.

Within some political discourse there is the narrative that; firstly, there are too many university graduates, and secondly that there are too many graduates in fields with lower paying jobs. The latter being the implication that Humanities, Arts and Literature hold less value than Science, Technology, Engineering and Mathematics. To achieve Net Zero more people in STEM-related careers is needed however this should certainly not be at the expense of the creative sectors of the economy. With respect to the balance between university graduates and those progressing though the FE system; the UK can just about manage with the number of STEM professional graduates however significantly more technical graduates are required.

There is a belief that resources be directed to elevate exceptional students, especially as means to uplift those from more deprived areas. Those that are exceptional should absolutely be given the opportunities to meet their potential irrespective of their background, however it is also important to recognise that it is not only a handful of talented individuals that will enable the delivery of industrial decarbonisation. The UK needs a workforce that is diverse, competent, motivated, and paid fairly. The way FE students and HE students can finance their studies is reflected in the above. Current finance models serve HE well where for FE students the options are more complicated and cover less despite the favourable job prospects for those following a more technical path. This needs to be addressed.

There is an acute shortage of technical skills to meet current demand in construction and to deliver industrial infrastructure, this shortage will be exacerbated as industrial decarbonisation programmes accelerate. As such the significant increase of the number of FE students in Engineering and Manufacturing Technologies and Construction, Planning and the Built Environment is required, the capacity to teach these subjects needs to be increased both through increasing available places at existing institutions and developing new ones. Unlike HE, where students are more mobile, FE students are less mobile and current student loans are less suited to funding living costs than HE. Given the challenge of increasing the number of technical graduates needed to support the delivery of the industrial decarbonisation the number and location of facilities is critical. There is an opportunity to align new learning facilities strategically close to industry and the centres of industrial decarbonisation. New facilities could further serve to uplift more deprived areas and provide opportunities for people to develop skills and competencies that prepare them for exciting and fulfilling jobs in the sector. The gap between classroom-based learning and practical technical on-site learning remains a challenge especially, though not limited to, more specialised skills that may include safety implications. Apprenticeships play a role however more specialised facilities should be developed. A good example being the Catch £12 million training facility in North East Lincolnshire, that offers industry authentic training and assessment without the risks associated with processing hazardous materials.

Where the primary challenge with FE is the quantum of diverse graduates, for HE diversity and inclusion, especially attracting more women, needs to be the focus. There are roughly the same number of students enrolled in HE as FE (see Figure 6) however the workforce requires 28% professional and 72% technical to deliver industrial decarbonisation (see Figure 4). There are still challenges with the number of HE graduates, however industry has proven over time to be able to reasonably adapt to these challenges. Thus, the number of graduates is generally adequate, and any additional growth should be sought within existing universities. As with FE, given that much of the same skills and competencies are used to deliver large scale industrial infrastructure today, the courses being taught at university broadly meet the needs of industry and will evolve organically as technology changes. Graduates will have the requisite foundation on which to build throughout their career, as such the CPD courses will play a role in developing skills and competencies as the technology for industrial decarbonisation develops.

Apprenticeships form a relatively small part of the mix of post-schooling skills and competency development (from HE, FE, and apprenticeships) but need to play an important role in developing the technical and practical skills/ competencies for industrial decarbonisation. A review of the Apprenticeship Levy and the behaviour it drives needs to be concluded. The apprenticeship levy shifted to higher levels and older / more skilled participants and is not serving its purpose or creating sufficient new opportunities with funds being deployed more for internal training opportunities.

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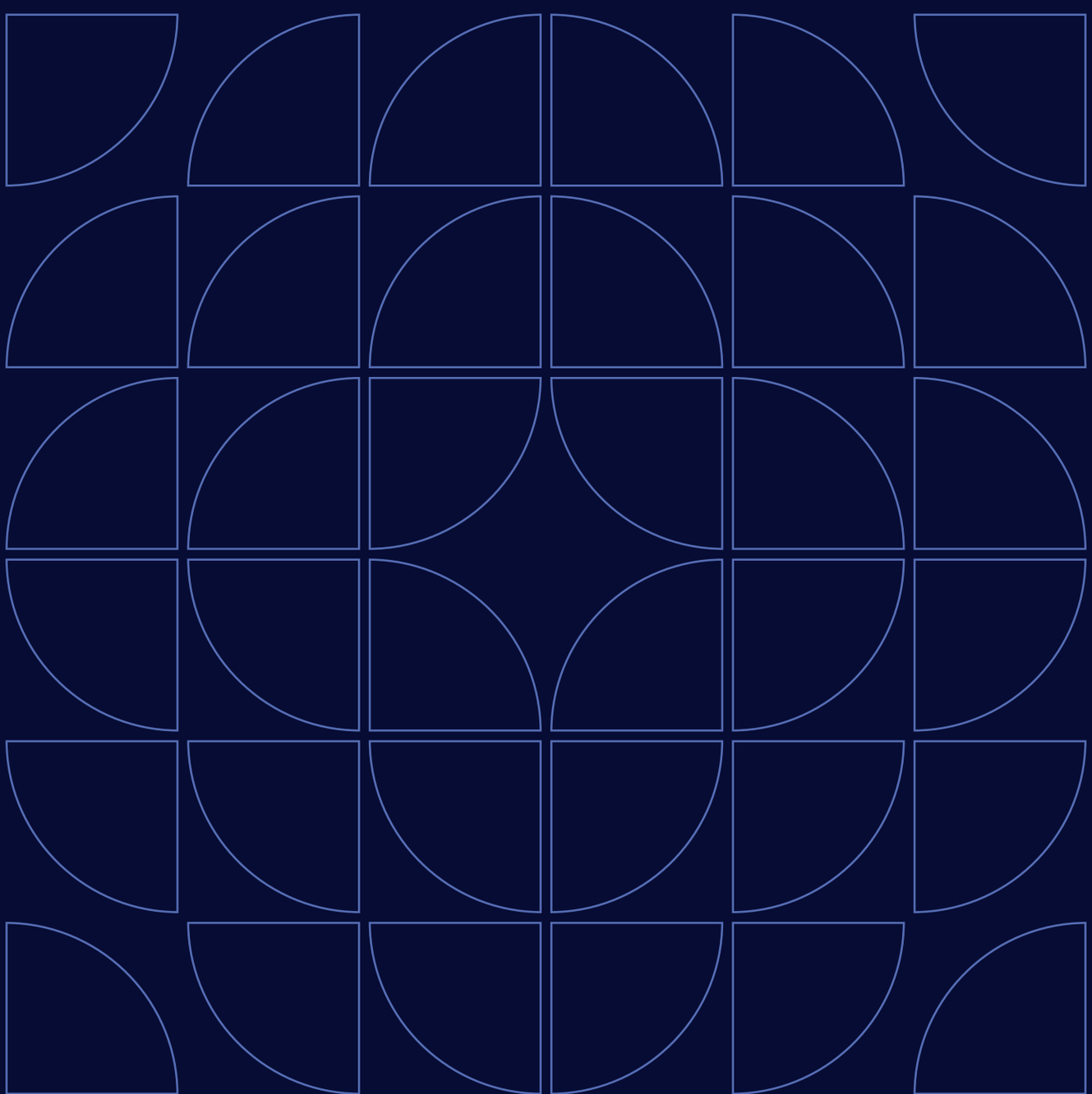
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