

# Transforming Foundation Industries – Future Skills

Final report



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**Contact:**

**Makenzie Keene**

**Tel: 020 7391 4119**

**email: mkeene@sqw.co.uk**

**Approved by:**

**Graham Thom**

**Managing Director**

**Date: 16/07/2021**

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# 1. Introduction

- 1.1** In November 2020, SQW was commissioned by UKRI/Innovate UK to conduct a study to assess the future skills needs for the Foundation Industries. The Foundation Industries (FIs), comprise the cement, glass, ceramics, paper, metals and bulk chemicals sectors. They produce the core materials that supply other manufacturing and construction firms.
- 1.2** Transforming Foundations Industries (TFI) is one of the wave 3 Industrial Strategy Challenge Funds (ISCF), which aims to support businesses to share expertise and develop radical innovations to increase their sustainability and remain internationally competitive. The Challenge will invest £149 million through the Industrial Strategy Challenge Fund (ISCF) to ensure these sectors make improvements to their energy and resource efficiency, meaning they are ready to meet the government commitment of Net Zero carbon emissions by 2050.<sup>1</sup>
- 1.3** As part of the Challenge, it was recognised that skills are a key element in driving/enabling innovation. Hence the commissioning of this study to better understand:
- current and future skills needs by sub-sector and across all sectors
  - commonalities and differences across the sectors
  - diversity and inclusion challenges, including current representation in the industries
  - how, and by which organisations, skills are supplied to the sub-sectors
  - potential gaps in meeting future skills needed to deliver improved competitiveness and Net Zero.
- 1.4** In this document we set out the key findings from the review and the actions developed to address the issues that have been identified.

## Methodology

- 1.5** This plan has been developed through four phases, summarised in Table 1-1 below.

**Table 1-1: Summary of study methodology**

Phase	Research methods	Output
<b>1 - Scoping (Nov-Dec 2020)</b>	<ul style="list-style-type: none"> <li>• Review of available literature on current and future skills needs for each sector</li> <li>• 13 scoping interviews with Innovate UK, sector representatives, Network+, HVMC and Universities</li> </ul>	Scoping report
<b>2 - Understanding the problem</b>	<ul style="list-style-type: none"> <li>• 'Understanding the problem' workshops, one with each of the six sectors, and</li> </ul>	Presentation of findings to Innovate UK

<sup>1</sup> [Getting to know: Transforming Foundation Industries - Innovate UK \(blog.gov.uk\)](https://blog.gov.uk/getting-to-know-transforming-foundation-industries)

Phase	Research methods	Output
<b>(Feb-March 2021)</b>	interviews, to identify common skills needs and challenges across the FI <ul style="list-style-type: none"> <li>• 54 participants including businesses, sector organisations and academics</li> </ul>	
<b>3 – Developing solutions (April 2021)</b>	<ul style="list-style-type: none"> <li>• Two further workshops, and interviews, to identify potential solutions to the FI skills challenges</li> <li>• First workshop on technical skills provision, second on management and leadership</li> <li>• Involved 22 individuals from within and outside the FI already delivering solutions to similar skills challenges</li> </ul>	Draft action plan
<b>4 – Test and develop (May – June 2021)</b>	<ul style="list-style-type: none"> <li>• Final workshop with 10 representatives from businesses and sector bodies from across the FI (who had participated in Phase 2) to test and develop the action plan</li> <li>• Revised the action plan based on feedback from the workshop</li> </ul>	Revised action plan, final report and presentation to Innovate UK

Source: SQW

- 1.6** A full list of the businesses and organisations consulted as part of this study can be found in Annex A: List of consultees

## Report structure

- 1.7** The report is structured as follows:

- Section 2 covers the context of the FIs in relation to skills
- Section 3 presents a summary of findings of the skills needs across the FIs
- Section 4 presents findings on good practice in addressing skills challenges
- Section 5 covers the action plan.

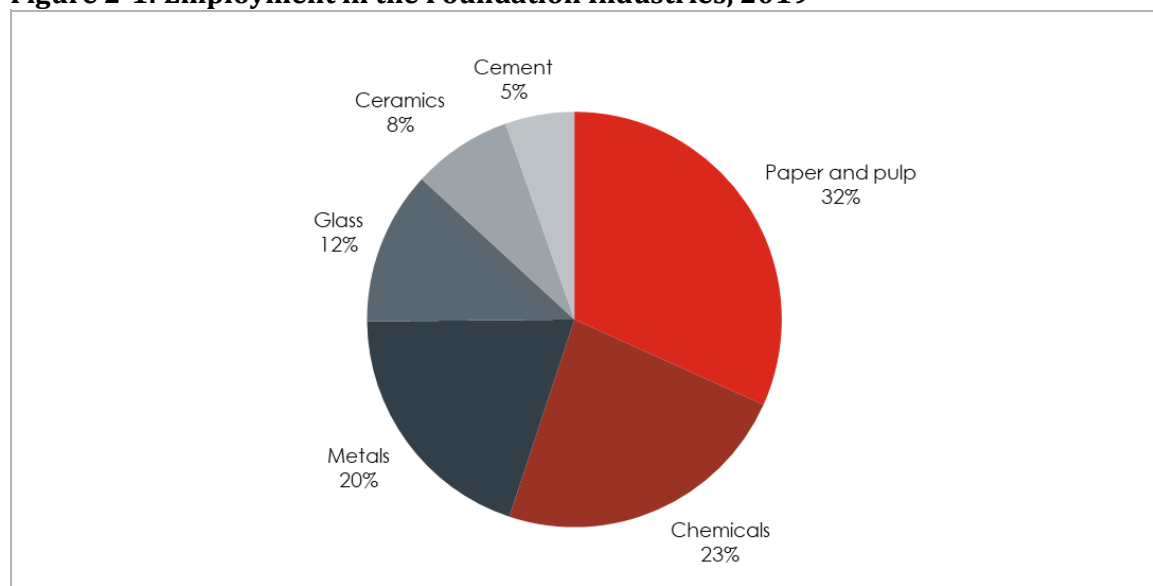
## 2. Context

- 2.1** This section sets out the context of the Foundation Industries (FIs) in terms of scale and location of employment.

### Relative size of sectors

- 2.2** In 2018, 5,146 businesses employing 176,000 people formed the FIs. Together, their turnover was over £53m and they generated GVA worth nearly £14m.<sup>2</sup> This sub-section uses the working definition of the FIs based on 2007 SIC codes for the six sectors (see Annex B:), as proposed by UKRI. The definition is strongly focused on primary producers rather than firms adding value to basic products. This has confined the study to a smaller group of businesses than other studies, but given the nuanced skillsets this study was looking to examine, this was decided to be the best approach.
- 2.3** By employment, paper and pulp was the largest sector, followed by chemicals and metals (see Figure 2-1). These three sectors account for almost three quarters of employment across the FIs.

**Figure 2-1: Employment in the Foundation Industries, 2019**



Source: ONS, 2019. Business Register and Employment Survey

- 2.4** As shown in Table 2-1, in the last decade employment in the FIs has decreased by 8% overall, with the largest decreases in the chemicals and ceramics industries. Employment in three of

<sup>2</sup> ONS, 2009 and 2019. Business Register and Employment Survey (BRES). This sub-section uses data from BRES rather than the Annual Business Survey (ABS), as used in the ongoing ISCF evaluation, due to discrepancies in the ABS employment data. BRES is a sample survey and produces estimated employment figures.

the six sectors decreased, while it was stable in two sectors, with a small increase of 2% in the paper and pulp sector.<sup>3</sup>

**Table 2-1: Employment in the Foundation Industries**

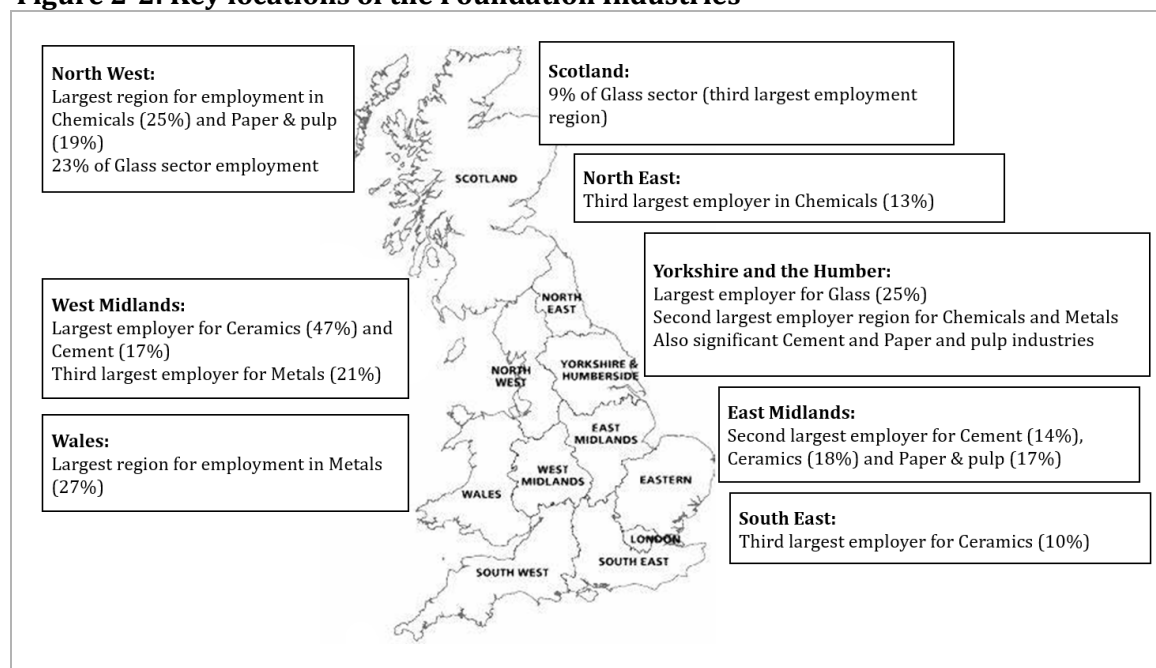
Sector	2009	2019	% change 2009-2019
Cement	9,000	9,000	0
Ceramics	15,000	13,000	-13
Chemicals	50,000	39,000	-22
Glass	20,000	20,000	0
Metals	36,000	33,000	-8
Paper and pulp	52,000	53,000	2
<b>Total</b>	<b>182,000</b>	<b>167,000</b>	<b>-8</b>

Source: ONS, 2019. Business Register and Employment Survey. A change in methodology between 2009 and 2019 means that the 2009 figures exclude units registered for PAYE only.

## Location of sectors

- 2.5** While the FIs have national coverage and each sector is geographically distributed, some of the sub-sectors have specific geographic concentrations (see Figure 2-2).

**Figure 2-2: Key locations of the Foundation Industries**



Source: ONS, 2019. Business Register and Employment Survey.

- 2.6** This highlights an opportunity for the sector as it is largely based outside the Southeast and therefore can position itself for a key role as part of the government's levelling up agenda.

<sup>3</sup> Ibid.

## 3. Sectoral skills needs

**3.1** This section summarises findings on current and future skills needs in the FIs, with common messages across the six sectors on the future skills needs and problems anticipated meeting these discussed below. More detailed findings by sector can be found in Annex C:. These findings are based on:

- a review of available literature, based on latest sector materials (e.g., from available online trade journals and from sector bodies) and wider sources, using a structured list of search terms
- interviews with stakeholders from each sector
- six workshops conducted with businesses and sector bodies in each sector.

**3.2** A number of issues arose which were relatively common across the six sectors in relation to future skills needs:

- there was limited focus on the skills required to make adaptations for maintaining competitiveness in delivering Net Zero. Rather, the focus has been on short term skills needs and survival, particularly how to combat problems related to the ageing workforce and the related loss of their detailed technical knowledge
- leadership and management are viewed as key to overcoming challenges of ageing workforce and innovation needed to deliver on Net Zero – but skills and cultural barriers exist in this area. Whilst management and leadership was not explicitly recognised by all respondents, it was raised by some and implied by others, and is evident in the literature, for example, the ERC’s Innovation Readiness report<sup>4</sup> which finds underdeveloped management and leadership skills acts as a barrier to innovation in the FIs
- engineering skills, at professional and technician levels, are a key current skills gap which is expected to increase in future, as well as sector-specific technical knowledge and STEM skills more broadly
- the ability to practically apply skills in real-world settings, multi-disciplinary knowledge and wider ‘soft’ skills (e.g., communication, leadership, confidence, etc.) are also gaps, which pose barriers to problem solving and innovation
- there has been limited consideration of skills needed for digitalisation / automation in most sectors, due to a lack of knowledge of what will be needed rather than lack of need.

**3.3** Common problems were also anticipated meeting to meet skills needs, in particular:

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<sup>4</sup> Hopley, L. et al (2021) Innovation Readiness in the UK Foundation Industries

- there was a common perception that the sectors are not attractive to new entrants as they were seen as 'old and dirty' and located in unappealing locations. The Net Zero agenda was identified as providing an opportunity to generate interest in younger people
- dissatisfaction with the number and quality of graduates and professional applicants, along with concerns about their job readiness, with neither soft nor technical skills meeting expectations
- there is a lack of bespoke, sector-specific training provided in FE and HE, and a risk that technical knowledge is being lost as an ageing workforce retires and there is not thought to be suitable technical provision to train new entrants to replace them. Sectors within the FIs often lack scale to be able to influence provision, meaning university-level and apprenticeship provision is viewed currently as poorly matched to meet need
- the supply system is fragmented and confusing, which makes it difficult for businesses to engage as they find it difficult to find suitable provision, and if they do, to then assess its quality, and there is a lack of coordination between FE, HE and other providers
- the apprenticeship system is viewed as complex and difficult for many businesses to navigate, meaning many are dissatisfied and critical of the system and the levy, and do not feel the generic standards that have been developed meet their needs
- the issues of scale mean that collaboration across businesses and sub-sectors to coordinate supply is key, but this is currently limited. In many cases the industries are 'poorly joined up' and expressed challenges around collaborating with those whom they also see as competition. This diminishes purchasing power and the development of solutions, within and across the FIs
- many businesses in the FIs are internationally owned, meaning leadership, and therefore investment and strategic decisions, are offshore, which can constrain the ability of local management to invest in skills development
- very limited consideration of specific aspects of equality, diversity and inclusion (EDI) other than ageing workforce, but this is seen as an area of opportunity to broaden traditional recruitment channels
- these issues are exacerbated for SMEs, as they have less resources to investigate and address them.



## 4. Good practice in addressing skills challenges

**4.1** Throughout this research, areas of reported good practice in addressing skills needs and gaps have been identified, from both within and outside of the FIs. This section summarises these examples, and includes findings from:

- workshops and interviews with individuals from within and outside of the FIs who are already engaged in the delivery of solutions to address similar skills challenges to those facing the FIs
- an evidence review to identify good practice in institutions/arrangements established with businesses to improve skills.

### Developing solutions workshops and consultations

**4.2** After identifying the common messages related to future skills needs, SQW undertook a series of interviews and two workshops (one on technical skills provision and one on management and leadership). Those participating broadly agreed with the analysis of the issues set out above (see paragraphs 3.2 and 3.3), and added some additional reflections:

- the concept of 'Foundation Industries' is relatively new, and the industries themselves do not typically work together, which exacerbates issues of scale and means they do not have a strong profile or voice
- the issues are often more about a lack of demand than about supply, with business focussed on short term, commercial pressures
- the messages are very similar to those seen in other industries such as Life Sciences and Advanced Therapies, both of which have identified solutions for some of these issues and their experience should be drawn on by the FIs
- there is a high information barrier (particularly for small businesses) for accessing training and finding the right kind of help with a range of different routes available
- similarly, there is a lack of understanding of the apprenticeship system, which can be seen as 'inaccessible and clunky', and how to best make use of generic apprenticeship standards
- the perception of apprenticeships – which in many cases is quite a 'traditional' view of apprentices with limited knowledge of the current system including how it includes degree level courses and can support leadership and management development
- equality, diversity and inclusion have risen up the agenda of many organisations and there is a risk that if the FIs do not engage then the labour pool they have access to will be limited

- there are mixed approaches to funding management and leadership training (businesses paying for staff, reimbursement, or employees paying themselves) which indicates the level of commitment from business (though paying and finding the time for this training is a considerable constraint for SMEs).

**4.3** Participants were then asked to identify possible solutions and examples of good practice the FIs might learn from to address these issues. Several helpful examples were identified within sectors such as Advanced Therapies, Life Sciences, Aerospace and Nuclear and from organisations/arrangements such as Knowledge Transfer Partnerships (KTPs), Research and Technology Organisations (RTOs), the Technician Apprenticeship Consortium and the Science Industry Partnership (part of Cogent Skills).

**4.4** Key areas which emerged across the examples are the need to enhance knowledge and collaboration. In order to develop informed demand, businesses must understand what their skills needs are and how existing provision could help address these needs, and must share knowledge across industries. Collaboration across businesses helps to ‘pool demand’ to enable ‘purchasing power’ with providers for training and development at all levels; and collaboration between industry, providers and other stakeholders in the creation of training programmes can help ensure they are fit for purpose. A summary of more specific findings from this research are set out in Table 4-1.

**Table 4-1: Summary of findings from ‘developing solutions’ workshops / interviews**

Focus	Findings from workshops / interviews
Management and leadership	<ul style="list-style-type: none"> <li>• Programmes where employees are exposed to other sectors to develop leadership skills were seen as helpful (e.g., <a href="#">Leader 2 Leader</a>)</li> <li>• Leadership and management apprenticeships have been used successfully in Advanced Therapies</li> <li>• Management KTPs work well and could be used more</li> <li>• Investing the time to address ‘information issues’ and provide communications to drive demand, explaining the need for innovation and training (as has been done in the Aerospace sector)</li> <li>• Internal leadership development programmes which look to advance leadership skills through opportunities on the job, coaching and mentoring and through classroom learning seen as good practice (but often only available in larger firms)</li> <li>• Some form of ‘central service’ is needed to address information barriers and issues identified to drive demand. Examples of past UK government approaches such as business advice service and innovation counsellors/advisers, were suggested, although views on their success were mixed.</li> </ul>
Apprenticeships	<ul style="list-style-type: none"> <li>• Need to map apprenticeship standards and develop understanding of emerging skills at different levels (as has been done for HVMC)</li> <li>• Businesses can go to providers which offer a generic apprenticeship standard and work with them to adapt provision to their specific needs</li> <li>• ‘Pooling’ apprenticeships, bringing together several businesses with similar apprenticeship needs, is a way to give businesses ‘buying power’ with providers</li> </ul>

Focus	Findings from workshops / interviews
	<ul style="list-style-type: none"> <li>• Having a facilitator between industry and providers and bringing businesses together to educate them was seen as a helpful way to disentangle the often-confusing apprenticeship landscape</li> <li>• Apprenticeship Consortium Model (Advanced Therapies and Technicians)</li> <li>• Showcase existing apprentices to employers to demonstrate what they are capable of</li> </ul>
Degree level apprenticeships	<ul style="list-style-type: none"> <li>• Materials Science Degree Apprenticeship (Sheffield Hallam and Derby) was seen as a good option for the FIs. It broadly covers training to become a Materials Engineer, but has flexibility so apprentices can get knowledge and skills for particular sectors</li> <li>• Level 6 and 7 apprenticeships and other higher education programmes are still a struggle for other sectors (Advanced Therapies and Life Sciences). The providers are less flexible, and it is more difficult to get 'buying power'. Takes longer for higher education institutions (HEIs) to get programmes started (approx. 2 years).</li> </ul>
Graduates / work placements	<ul style="list-style-type: none"> <li>• 'Sandwich placements' were seen as a good way for graduates to get practical industry experience to complement their academic qualifications</li> <li>• Can be difficult for businesses to navigate, having a facilitator can help businesses understand how it works, what they can do, how to manage etc.</li> <li>• Nucleargraduates was viewed as an example of a successful programme. Students undertake three secondments over 2 years, with core training programme, mentoring, networking opportunities and a 'significant role' in a sponsor organisation at the end of the programme.</li> </ul>
Other training options	<ul style="list-style-type: none"> <li>• KTPs work well, particularly for SMEs with management buy-in as they can influence management culture, innovation and strategy</li> <li>• German Fraunhofer model, constant cycle of staff transferring between industry and RTOs (but very expensive)</li> <li>• Collaborative PhDs being undertaken with larger organisations have worked well. Practical milestones agreed alongside academic milestones</li> <li>• Online training platform, bringing together all existing online training and CPD activities (as has been done in Advanced Therapies)</li> <li>• Investing in a centre for training and/or new technologies</li> <li>• Potential areas to explore in the future: Institute of Technology (IoT), Academic Technology Approval Scheme (ATAS, from DfE), Learning Factories, Skills Accelerator.</li> </ul>
Mentoring / coaching	<ul style="list-style-type: none"> <li>• Internal mentoring and coaching programmes were seen as very important but need to have buy-in from leadership</li> <li>• Reverse mentoring, with younger employees mentoring older employees, was seen as just as important as traditional mentoring, particularly to combat issues around the ageing workforce and digitalisation</li> <li>• Formalising mentoring programmes, for example through certification, was seen as a way to give it greater value within and outside of the business.</li> </ul>
Sector image	<ul style="list-style-type: none"> <li>• Important to engage with education at all levels</li> <li>• Engaging with the Careers and Enterprise Company, representatives from industry volunteering as Enterprise Advisers</li> <li>• Engaging with the STEM Ambassadors programme</li> </ul>

Focus	Findings from workshops / interviews
Regulation	<ul style="list-style-type: none"> <li>• More regulated/structured system potential solution to ensure working engineers keep skills up to date, including mandatory CPD instead of voluntary</li> <li>• Use Innovate UK funding power to influence businesses towards better behaviour. This could mean asking for commitments to workforce development when seeking other funding. It could also reinforce links between technology and business development, and skills developments</li> </ul>

*Source: SQW Phase 3 'Developing solutions' workshops and interviews*

## Evidence review

**4.5** A review of evidence to identify good practice in institutions/arrangements established with businesses to improve skills on a sectoral basis found several fairly common and strong themes to guide to any grouping:

- clarity of purpose (and then consistency over time) driven by the sector
- shaped and guided by a sound evidence base
- sufficient resources (people and money) to be credible and take on the agreed purpose, which can include being able to generate income through membership fees or services including training and consultancy
- the importance of employer buy-in
- drawing on existing relationships to attract key members (most obviously employers but also recognising the need to engage the supply side)
- recognise the barriers to engaging small firms and work to overcome these barriers.

## 5. Action plan

- 5.1** The findings from the first three phases of this project were brought together to develop an Action Plan. The plan brings together the skills challenges (and opportunities) faced by the FIs which might prevent the sector from meeting Net Zero and competitiveness goals and what Innovate UK can do to help resolve those issues.
- 5.2** A draft plan was presented in a workshop in May 2021 to representatives from FI businesses and sector bodies who had participated in phase 2 of this study to ‘test and develop’ the suggested actions. Feedback from this workshop has been incorporated into the plan presented below (Table 5-1). In particular we have focussed down on a series of key action areas and themes.
- 5.3** There are four themes in the plan, although as is shown, many of the actions will address more than one theme:
- raise awareness of net zero and demand for skills within FIs
  - develop management and leadership
  - improve skills provision
  - improve sector attractiveness.
- 5.4** In developing the actions, we were mindful of:
- the lack of an existing group to bring together and articulate the employer voice in driving the need for change. There is a need to identify and engage with key sector business and to develop a Taskforce to help progress the action plan. Their ownership and leadership of the Action Plan would (according to the evidence on best practice) help attract others in the sector. This is a key component of other sectors which have developed and taken forward similar plans, e.g., life-sciences, construction
  - the breadth of the agenda to be addressed. We have focussed on a fairly small number of action areas (10). In many cases, several activities will need to be taken forward in each action area, and while we have suggested in places what these could be, we anticipate the focus and detail will be guided by the Taskforce
  - a need to raise the demand for skills within the sector. It will not be sufficient to make changes to the supply of skills alone. The sector needs to be convinced of the value of investment in skills and investment in engagement with education providers for the longer-term
  - a need to work with existing structures and systems for the benefit of the FIs. There is a significant short-term agenda to move forward, rather than delay actions until wider changes can be achieved

- there are some good practice examples which could be used as demonstrators or to develop guidance for others. However, for the most part, Innovate UK will need to facilitate / commission skills development activities, testing the market where there are multiple generic (i.e. non-sector specific) providers, particularly for management and leadership activities.

**5.5** Many of the actions set out are independent of others and would have value on their own. However, to emphasise what was said above, we do think it important that the Task Force is able to influence the shape of activity. We would also suggest that some progress is made quickly to create a sense of momentum and achievement, which should then lead to more. Actions 3, 4, 5 and 8 could be early actions.

**5.6** In general, the actions need not be sequential, although incentivising skill development through IUK funding should follow the Taskforce being in place and action to improve supply. Action around the supply side would help to demonstrate a partnership approach, with all sides being asked to play their part.

**Table 5-1: Action Plan for the Foundation Industries**

Action	Theme			
	Raise awareness of net zero and demand for skills within FI	Develop management and leadership	Improve skills provision	Improve sector attractiveness
1. Establish a TFI Innovation Skills Taskforce (TFIIST) which has a clearly defined purpose and objectives, comprises a coalition of enthusiastic employers and leads on the detailed design and delivery of the action plan	√	√	√	√
2. Link TFIIST to Advisory Group (and other FI groups), ensuring skill-related objectives are included in the Terms of Reference of those groups	√	√	√	√
3. Develop a single, online point of access for FIs which articulates the need for skills investment and signposts to resources. In the short term this should highlight courses which are currently available and wider UKRI resources (mapped to show relevance to FIs).  In time this could expand to include opportunities developed through TFIIST such as: Management Degree Apprenticeships; FIs relevant skills provision; mentoring and reverse mentoring, M&L mentoring and cross organisational secondments; and an FIs graduate programme.	√	√	√	√
4. Convene and pool informed employer demand for skills and facilitate discussions with providers to i) improve provision, using tailored generic frameworks and ii) improve provider capacity	√	√	√	√

Action	Theme			
5. Support a pilot group of employers to employ Apprentices (if possible, one group at Level 4/5 and one Degree Apprenticeship) to demonstrate how existing Apprenticeships Standards can be used to ensure sufficient demand to be attractive to providers. In doing so draw on the experiences of those in the sector using apprenticeships at present.	√	√	√	√
6. Facilitate business engagement in curriculum design, student sponsorship opportunities			√	√
7. Commission bespoke short-course provision for FI innovation management. Promote use of <a href="#">Management Knowledge Transfer Partnerships</a> and engage with <a href="#">Help to Grow Expert Advisory Council</a> to explore possibilities for delivery of innovation management provision		√		
8. Develop a narrative for FI, encapsulating critical role in Net Zero and associated skill requirements. Communicate the narrative to sector, potential entrants and other government departments	√			√
9. Work with partners to position the sector as a career choice (e.g. STEM Ambassadors, Careers Enterprise Company, Skills Development Scotland) and promote diversity (e.g. through working with Women in Science and Engineering)			√	√
10. As capacity improves, incentivise learning activities through IUK funding. This could include asking those bidding for funding to commit to hiring apprentices, taking on student placements, secondments, etc.	√	√	√	√

Source: SQW



## Annex A: List of consultees

**A.1** Throughout this study, representatives from 67 businesses, sector bodies, education and training providers, and other relevant organisations were consulted through workshops and interviews (see Table 1-1). A full list can be found in **Error! Reference source not found.** below.

**Table A-1: Businesses/organisations consulted throughout study**

Business/organisation	
Advanced Therapies Apprenticeship Community	Institute of Materials, Minerals and Mining (IOM3)
Alpek Polyester UK Ltd	James Cropper Plc
AluCast Ltd	Johnson Matthey
Applied Materials Research, Innovation & Commercialisation Company (AMRICC)	Knowledge Transfer Network (KTN)
Arjowiggins	M&C Educational Training Ltd
Aston University	Mantec Technical Ceramics
BASF	Materials Processing Institute (MPI)
Beatson Clark	Mineral Products Association (MPA)
Brafe Engineering Ltd	Minerals Products Qualification Council (MPQC)
Breedon Cement	Mitsubishi Chemical Methacrylates (Lucite International)
British Ceramic Confederation	Newcastle Business School
British Glass	Nucleargraduates
Cardiff University	O-I Glass
Cast Metals Federation	Palm Paper
Celsa Steel UK	Paper Industry Technical Association (PITA)
CEMEX UK	Petrofer UK
Centre for Process Innovation (CPI)	Robinson Brothers Ltd
Chemical Industries Association (CIA)	Royal Academy of Engineering
Croda International Plc	Science Industry Partnership SIATE
Encirc	Sheffield Hallam University
Engineering UK	Thomas Dudley Ltd
Fourstones Paper Mill Company	UK Chemistry Council
Gatsby Foundation	UK Metals Council
George Taylor & Co (Hamilton) Ltd	UKRI EPSRC
Glass Futures	UKRI Innovate UK
Glass Technology Services	University of Bath

Business/organisation	
Guardian Glass	University of Birmingham
HancockHamlin Ltd	University of Leeds
Hanson Cement	University of Sheffield
High Value Manufacturing Catapult (HVMC)	University of South Wales
Ibstock PLC	University of Warwick
Iggesund Paperboard Ltd	Wedge Galvanising
Inprotec Ltd	

*Source: SQW*

## Annex B: SIC codes for Foundation Industries

- B.1** As there is no agreed definition of foundation industries, the TFI challenge team provided a working definition based on 2007 SIC codes, shown below. It was noted that this definition is relatively narrow, focusing predominantly on the primary producers.

**Table B-1: SIC codes for Foundation Industries**

SIC Code	Description
<b>Paper and pulp</b>	
17110	Manufacture of pulp
17120	Manufacture of paper and paperboard
17211	Manufacture of corrugated paper and paperboard, sacks and bags
17219	Manufacture of other paper and paperboard containers
17220	Manufacture of household and sanitary goods and of toilet requisites
17230	Manufacture of paper stationery
17240	Manufacture of wallpaper
17290	Manufacture of other articles of paper and paperboard n.e.c.
<b>Chemicals</b>	
20110	Manufacture of industrial gases
20130	Manufacture of other inorganic basic chemicals
20140	Manufacture of other organic basic chemicals
20150	Manufacture of fertilizers and nitrogen compounds
20160	Primary plastics
20590	Manufacture of other chemical products n.e.c.
<b>Glass</b>	
23110	Manufacture of flat glass
23120	Shaping and processing of flat glass
23130	Manufacture of hollow glass
23140	Manufacture of glass fibres
<b>Ceramics</b>	
23310	Manufacture of ceramic tiles and flags
23320	Manufacture of bricks, tiles and construction products, in baked clay
23410	Manufacture of ceramic household and ornamental articles
23420	Manufacture of ceramic sanitary fixtures
23430	Manufacture of ceramic insulators and insulating fittings
23440	Manufacture of other technical ceramic products
23490	Manufacture of other ceramic products n.e.c.

SIC Code	Description
<b>Cement</b>	
23510	Manufacture of cement
23520	Manufacture of lime and plaster
23630	Manufacture of ready-mixed concrete
23640	Manufacture of mortars
23650	Manufacture of fibre cement
<b>Metals</b>	
24100	Manufacture of basic iron and steel and of ferro-alloys
24410	Precious metals production
24420	Aluminium production
24430	Lead, zinc and tin production
24440	Copper production
24450	Other non-ferrous metal production

*Source: Transforming Foundation Industries Challenge Team*

## Annex C: Findings from ‘understanding the problem’ research by sector

**C.1** Table C-1 and **Error! Reference source not found.** below provide detailed summaries of the findings on current and future skills needs in the Foundation Industries and problems anticipated in meeting these needs, by each of the six sub-sectors.

**Table C-1: Summary of findings on (current and) future skills needs**

Sector	Leadership and management	Professional skills	Apprenticeships	Digitisation / automation
Cement	<ul style="list-style-type: none"> <li>Change management</li> <li>One firm identified: Emotional Intelligence, effective negotiations, remote collaboration, complex problem solving, critical thinking, creativity</li> </ul>	<ul style="list-style-type: none"> <li>Chemical, mechanical, heat and electrical (High Voltage) engineers</li> <li>Heavy engineering – plant maintenance</li> <li>Full range of STEM</li> <li>Environmental/biodiversity experts for decarbonisation</li> <li>Net Zero knowledge: CCS, carbon/energy management, alternative fuels, emissions</li> </ul>	<ul style="list-style-type: none"> <li>No specific skills needs identified</li> </ul>	<ul style="list-style-type: none"> <li>Lack of software specialists/ software and analytical skills/ AI/ digitisation</li> </ul>
Ceramics	<ul style="list-style-type: none"> <li>Little engagement with net zero skills agenda, focus on current/imminent skills needs (e.g., ageing workforce)</li> </ul>	<ul style="list-style-type: none"> <li>Technical knowledge is a current (and anticipated future) skills need: science, engineering, practical and multi-disciplinary</li> <li>Innovation will be needed to drive change, so technical skills underpinning this are fundamental</li> <li>Shortages in process and thermal engineering</li> </ul>	<ul style="list-style-type: none"> <li>Current gap in detailed understanding of the basics of ceramics manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>No specific skills needs identified</li> </ul>
Chemicals	<ul style="list-style-type: none"> <li>Challenges defining (and agreeing a definition of) Net Zero – sector-wide carbon literacy/education needed</li> <li>Need people who ‘can facilitate, negotiate and think disruptively’</li> </ul>	<ul style="list-style-type: none"> <li>Engineering (particularly mechanical and process) and technical skills now and in the future (energy and heat engineering)</li> <li>Need skills in research, development and innovation to develop, test and implement new technologies</li> </ul>	<ul style="list-style-type: none"> <li>Difficult for businesses to navigate the system to find suitable apprenticeships</li> </ul>	<ul style="list-style-type: none"> <li>‘Key’ to reaching Net Zero</li> <li>Companies currently undergoing</li> </ul>

Sector	Leadership and management	Professional skills	Apprenticeships	Digitisation / automation
	<ul style="list-style-type: none"> <li>• Balance of different leadership skills needed in individuals/teams – technical, business and people</li> <li>• Wider skills – communication, leadership, confidence, innovative thinking, and emotional Intelligence</li> </ul>	<ul style="list-style-type: none"> <li>• Skills in scale-up and translating into manufacture; commercial skills</li> <li>• Practical/'job readiness' skills, particularly at the technician level</li> <li>• STEM skills</li> <li>• Collaboration between disciplines and a pragmatic understanding of sustainability</li> </ul>	<ul style="list-style-type: none"> <li>• Practical application of skills/technology is a current skills gap, particularly at technician level</li> </ul>	<p>'digital transformation'</p> <ul style="list-style-type: none"> <li>• Specific needs differ, from digital process skills to mathematical modelling skills</li> </ul>
Glass	<ul style="list-style-type: none"> <li>• Often those in leadership are technical experts who have been in sector a long time – gap in skills for managing/driving change, influencing – which will be needed in relation to Net Zero</li> <li>• Current lack of skills in delivering training/development</li> <li>• Limited leadership and management – too often focussed on costs not growth</li> </ul>	<ul style="list-style-type: none"> <li>• Technical knowledge a current gap: chemistry, process/chemical engineering</li> <li>• Demand for specific engineering skills likely to grow as industry moves toward more automated processes (specifically energy and furnace engineers)</li> <li>• Gap in real-world application, and industry specific knowledge</li> </ul>	<ul style="list-style-type: none"> <li>• Need to assess aptitude to working in plant environment when recruiting for some roles (e.g., furnace operators), rather than skillset, as skills far removed from requirements</li> <li>• Increased demand for apprenticeships to replace ageing workforce</li> <li>• Need better apprenticeship routes</li> </ul>	<ul style="list-style-type: none"> <li>• Recognised as a need, but limited consideration</li> </ul>
Metals	<ul style="list-style-type: none"> <li>• Industry focused on current problems rather than looking ahead to future challenges including Net Zero (linked to large proportion of SMEs in industry and limited resource)</li> </ul>	<ul style="list-style-type: none"> <li>• Engineers – particularly mechanical engineers and electrical engineers</li> <li>• Metallurgy longstanding skills gap, with expected problems linked with ageing workforce</li> </ul>	<ul style="list-style-type: none"> <li>• Engineers at technician level (a longstanding problem)</li> </ul>	<ul style="list-style-type: none"> <li>• Knowledge of new technologies needed for electrification, new alloys and new processes</li> </ul>

Sector	Leadership and management	Professional skills	Apprenticeships	Digitisation / automation
	<ul style="list-style-type: none"> <li>Limited leadership and poor innovation management</li> </ul>	<ul style="list-style-type: none"> <li>Well-rounded skills – technical and practical skills alongside communication and other wider skills</li> <li>Need skills in research, development and innovation to develop, test and implement new technologies, and understanding of highly productive new technologies</li> </ul>		<ul style="list-style-type: none"> <li>Digitisation will lead to some automation</li> </ul>
Paper	<ul style="list-style-type: none"> <li>Recognition of importance of Net Zero, but at present focus on productivity and sector survival (rather than skills)</li> <li>Energy market knowledge a current gap (viability/suitability of renewable energy modes for a site)</li> </ul>	<ul style="list-style-type: none"> <li>Current challenges recruiting for relevant engineering skills, especially related to heat and electrical engineering</li> <li>Intimate process knowledge a potential barrier to innovation needed for Net Zero</li> <li>Lack of R&amp;D and innovation skills</li> </ul>	<ul style="list-style-type: none"> <li>Most training of new entrants currently through apprenticeship schemes</li> </ul>	<ul style="list-style-type: none"> <li>Recognised future need, exploring skillset – data and digital engineers should come from within the sector as understanding of systems/ processes needed</li> </ul>

Source: SQW based on available literature, consultations with stakeholders and industry workshops

**Table C-2: Summary of findings on problems anticipated in meeting skills needs**

Sector	Sector image	Sector culture	Skills supply	EDI
Cement	<ul style="list-style-type: none"> <li>Need help to promote the sector to chem engineers, and other professional groupings who would not think of a career in the sector (e.g., biodiversity)</li> <li>Sector described as ‘invisible’: rural, not</li> </ul>	<ul style="list-style-type: none"> <li>Welcome having research focussed on business needs not academic – business should take advantage of that</li> <li>Product is heavily regulated – can stifle innovation</li> </ul>	<ul style="list-style-type: none"> <li>There is a lot of in-house training and they ‘just get on with it’, less reliance/ critique of skills supply than other sectors</li> <li>Well-paid apprenticeship schemes currently exist, and examples of graduate schemes and internal technical management training by large</li> </ul>	<ul style="list-style-type: none"> <li>Ageing workforce, no other specific issues identified</li> </ul>

Sector	Sector image	Sector culture	Skills supply	EDI
	many vacancies, few career pathways/high level roles (but Net Zero as a challenge could help tackle that)		businesses. Pockets of HEI provision in places. <ul style="list-style-type: none"> <li>Challenges generating the volume where provision can be not too general, but a right 'entry level'</li> </ul>	
Ceramics	<ul style="list-style-type: none"> <li>No specific problems identified</li> </ul>	<ul style="list-style-type: none"> <li>Traditional mindsets in leadership, approach to recruitment and skills development (and Net Zero) – 'inflexible' to take on new skills</li> <li>Poor innovation culture</li> <li>Sector has not been proactive about skills development in the past; further industry engagement with skills supply needed, as has taken place for development of materials technology degree apprenticeship</li> <li>Small sector so collaboration needed to ensure sustainable demand; need for better sharing of expertise and skills across the sector</li> <li>Difficult to bring sub-sectors of industry together to realise similarities and common issues – fragmentation</li> </ul>	<ul style="list-style-type: none"> <li>No longer a ceramics-specific degree route, contributing to graduates' lack of technical knowledge</li> <li>No specific apprenticeship offer at Level 2/3 for ceramics, but felt that this is needed</li> <li>Lack of funding for training</li> </ul>	<ul style="list-style-type: none"> <li>Ageing workforce, no other specific issues identified</li> </ul>
Chemicals	<ul style="list-style-type: none"> <li>View that industry is 'dirty' means graduates are lost to other industries; Net Zero may be an opportunity to attract younger people into industry</li> </ul>	<ul style="list-style-type: none"> <li>Challenges with attracting workforce to move around the country</li> <li>Internal promotion and mobility (and planning for this) important for filling skills gaps (associated with ageing workforce)</li> </ul>	<ul style="list-style-type: none"> <li>Plenty of graduates, but less traditional science degrees not necessarily suitable for industry and those with 'right' qualifications/skills lost to 'more exciting'/better paid industries</li> <li>Diverse but fragmented supply system, plus industry poorly joined up for collaboration between businesses to</li> </ul>	<ul style="list-style-type: none"> <li>Ageing workforce</li> <li>Need for more diversity and diverse role models</li> </ul>



Sector	Sector image	Sector culture	Skills supply	EDI
	<ul style="list-style-type: none"> <li>• More engagement at school-level required</li> </ul>		<ul style="list-style-type: none"> <li>• deliver adequate size of cohort required by providers</li> <li>• Need to ensure apprenticeships are fit for purpose and more flexible; seen as important but criticism of the Levy</li> <li>• Key role of professional institutions</li> </ul>	
Glass	<ul style="list-style-type: none"> <li>• Challenges with conversion from other industries due to plant environment</li> <li>• Challenge recruiting outside of those with links already to plants; further promotion of and exposure to sector needed</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of confidence of the industry to promote itself as a desirable, competitive industry; Net Zero plans could be a selling point</li> <li>• Lack of sector wide approach; challenges with “competition rules” but need for better sharing of expertise and skills</li> <li>• More proactivity from industry to engage with universities needed</li> <li>• Poor innovation culture</li> </ul>	<ul style="list-style-type: none"> <li>• No glass technology offers at degree level – not viable for universities due to low demand (from students and small size of sector)</li> <li>• Apprenticeships encouraged by sector bodies to address skills gap but lack of specific apprenticeship offer; mixed feedback on suitability of engineering apprenticeship standards</li> <li>• Preference/need for modularised learning</li> </ul>	<ul style="list-style-type: none"> <li>• Ageing workforce</li> <li>• Recognition of importance</li> <li>• Broadening recruitment being considered as an enabler to overcoming skills shortages</li> <li>• Actions being taken in relation to gender balance</li> </ul>
Metals	<ul style="list-style-type: none"> <li>• Perception of industry as ‘dirty, environmentally unfriendly and at times sexist’ – difficult to attract and retain people (especially young people) and compete</li> </ul>	<ul style="list-style-type: none"> <li>• Difficult for SMEs to invest in training/skills development</li> <li>• Management reluctance to invest in skills/training</li> </ul>	<ul style="list-style-type: none"> <li>• Fragmented and confusing skills supply system which lacks continuity and is difficult for industry to engage with. But also a fragmented industry side</li> <li>• Lack of standalone, degree-level provision in metallurgy training (fundamental skill); but lack of history of engagement with HEI</li> </ul>	<ul style="list-style-type: none"> <li>• Ageing workforce</li> <li>• More widely a recognition that the talent pool is currently too narrow</li> </ul>

Sector	Sector image	Sector culture	Skills supply	EDI
	<p>with other industries like automotive and aerospace</p> <ul style="list-style-type: none"> <li>• Net Zero a good opportunity to encourage younger people into the industry</li> </ul>		<ul style="list-style-type: none"> <li>• Loss of Apprenticeship framework and now only metal casting (and frustration with the Levy)</li> <li>• Call for engagement at school and FE level</li> </ul>	<ul style="list-style-type: none"> <li>• Mentoring suggested as an action to address this</li> </ul>
Paper	<ul style="list-style-type: none"> <li>• Mixed messages. Some have strong local reputations, but even that is less useful for higher skilled posts</li> <li>• Net Zero potentially attractive selling point of sector to young people</li> </ul>	<ul style="list-style-type: none"> <li>• Poor innovation culture</li> <li>• Short-term challenges take precedence over mid- to long- term planning</li> <li>• Challenging to get some of industry to pay for training while others send people to Germany</li> </ul>	<ul style="list-style-type: none"> <li>• Very limited UK provision as low take up ended previous programmes (scale of sector an issue)</li> <li>• Majority of specialist training delivered in Germany</li> <li>• One apprenticeship available at Level 3, developed through the Trailblazer Apprenticeship Programme in 2016, currently being revised</li> <li>• Limited HEI/industry collaboration</li> <li>• Call for engagement at school level</li> </ul>	<ul style="list-style-type: none"> <li>• Ageing workforce, no other specific issues identified</li> </ul>

Source: SQW based on available literature, consultations with stakeholders and industry workshops

# SQW

## Contact

For more information:

**Graham Thom**

*Director, SQW*

T: +44 (0)131 2 43 07 36

E: [gthom@sqw.co.uk](mailto:gthom@sqw.co.uk)

48 Melville Street  
Edinburgh  
EH3 7HF

[www.sqw.co.uk](http://www.sqw.co.uk)

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