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Transforming Foundation Industries – Industrial Strategy Challenge Fund Evaluation

Baseline Report

SQW

Contents

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1. Introduction

1.1 The Transforming Foundation Industries (TFI) Industrial Strategy Challenge Fund (ISCF) programme includes six sectors within the foundation industries: ceramics, glass, cement, metals, paper and chemicals. The Challenge seeks to keep the foundation industries (FI) internationally competitive and minimise their environmental impact through supporting collaboration, stimulating investment and de-risking innovation investment. The TFI programme is part of the Clean Growth Grand Challenge within the UK Government's Industrial Strategy. It has been allocated £66 million between 2019 and 2024 through the wider £4.7 billion ISCF. This is expected to translate into an additional investment of £83m from the private sector, potentially providing a total fund size of £149 million.

1.2 SQW, together with the Institute for Manufacturing (IfM), IFF Research and Cambridge Econometrics (CE), and a panel of sector experts, has been commissioned to evaluate the TFI ISCF. The evaluation will run from July 2020 to March 2024. The evaluation has four phases:

- Phase 1 – development of the evaluation framework, July 2020 to March 2021 (completed)
- Phase 2 – baselining, November 2020 to May 2021 (current report)
- Phase 3 – interim evaluation (process and progress), January 2022 to October 2022
- Phase 4 – final evaluation (impact), January 2023 to March 2024.

1.3 The evaluation framework outlined an agreed understanding of the rationale for the programme, its key aims, and the expected routes to achieving those aims (the summary logic model is provided in Annex A) and presented the overall approach to the evaluation and the specific methods.

1.4 The purpose of this baseline report is to present evidence on the position of the FI at the point at which the TFI Challenge commenced and marks the first step in implementing the evaluation framework. Understanding the baseline will:

- Provide the TFI team with insights regarding the FI and its constituent sectors to inform how they deliver the programme
- Set the starting point against which progress can be measured during the impact evaluation in 2023.

1.5 The report contains evidence from two main sources, which are reported on separately at this stage:

- A survey of businesses from the FI with 400 responses
- Analysis of secondary datasets relevant to the FI.

1.6 The survey offers direct feedback from companies within the FI regarding some of the key metrics the TFI programme is interested in, including how businesses perceive the FI, attitudes to innovation, innovation activity, R&D investment, collaboration, skills and net zero. Together, the survey and secondary data analysis set the context in which the programme is operating. They supply bottom up and top down evidence on aspects of the theory of change such as assumptions, drivers of change and barriers.

1.7 It is worth noting that, as delivery of the TFI programme only commenced fully in 2020, this baseline report does not contain any information on implementation to date. Both the survey and the secondary data analysis only provide information regarding the whole population of Foundation Industries (for sectors included in the FI see Annex B). No evidence has been collected from beneficiaries regarding delivery, experience or benefits.

1.8 Subsequent research during the process and impact phases of the evaluation in 2022 and 2023/24 respectively will provide evidence on how the programme has been delivered, what it has achieved and what has been learned. This will include a second wave of the business survey which will cover beneficiary companies as well as non-beneficiary companies from across the FI, presenting the opportunity to measure the progress of these groups against the baseline. The secondary data analysis will also be updated to supply the necessary context in which to understand any changes detected from the primary research. A diagram depicting all the evaluation methods is shown in Annex C.

1.9 This is a draft report subject to review by the TFI team and should not be shared more widely.

Report structure

1.10 The report is structured as follows:

- Section 2 presents a description of the respondents to the business survey
- Section 3 sets out findings from the business survey
- Section 4 provides the baseline performance of the FI on key metrics, including international comparisons, and the baseline projections for the FI.

1.11 The following annexes are included as part of the report: a summary logic model; SIC codes for the Foundation Industries; the evaluation methods; the evaluation metrics; definitions and sources of data for secondary analysis; Covid-19 assumptions for economic projections; and secondary data analysis by sector.

2. Business survey respondents

Overview of survey

2.1 The purpose of the business survey is to obtain information directly from FI companies that is not available from secondary datasets including: perceptions of the FI; innovation attitudes and activity; perceived barriers to innovation; collaborative relationships within industry and with academics; behaviours towards environmental sustainability; and skills and capabilities.

2.2 The survey will have two waves: a baseline survey of companies from across the FI in 2021 and a second wave of both beneficiary and non-beneficiary companies at impact evaluation stage in 2023. This section presents findings from the baseline survey.

2.3 The business database holding details of FI companies used for the survey was purchased from 'Market Location'. The sample was stratified in order to achieve fair representation of companies across the six sectors. Within this, the database was sampled on a random basis to ensure spread by size, region and so on. The table below shows the starting sample for each sector, the number of achieved interviews, and the weighted number of responses. The responses were weighted to allow for the fact that some sectors were over-sampled (cement, glass and ceramics) and some were under-sampled (paper and metals). The survey responses were weighted by company size and sector according to Business Population Estimates (BPE)[1] based on the FI SIC codes[2]. All analysis uses the weighted data. Due to weighting, there are some cases where totals might not sum correctly due to rounding errors.

Table 2-1: Business survey sample

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	Total
Starting sample	1307	889	310	497	112	892	4007
Interviews achieved	63	95	63	70	24	85	400
Weighted number of respondents	94	90	53	30	71	61	400

Source: IFF Research

2.4 The survey questionnaire was shared with UKRI for review and comment before finalising and piloted prior to full roll out. The CATI[3] survey comprised mainly closed questions and the average duration was 20 minutes. The survey was conducted by IFF Research.

2.5 The analysis has provided two perspectives. First, we have analysed and interpreted the results for the FI as a whole. Second, we have been able to look at the individual sectors of the

[1] Business population estimates 2020 - GOV.UK (www.gov.uk)
[2] Table 7 in the BPE database provides the relevant population counts but only to the 3-digit level whereas the FI SIC codes include 4/5-digit SIC codes.
[3] Computer Assisted Telephone Interview.

FI, in relation to the whole and to the other sectors. There were too few respondents to undertake analysis at a sub-sector level.

Description of survey respondents

2.6 The business survey received 400 responses. Below we give a description of the characteristics of respondents. **Note, all survey analysis uses weighted data with the exception of Figure 2-1 which shows the actual proportion of respondents across the sectors.**

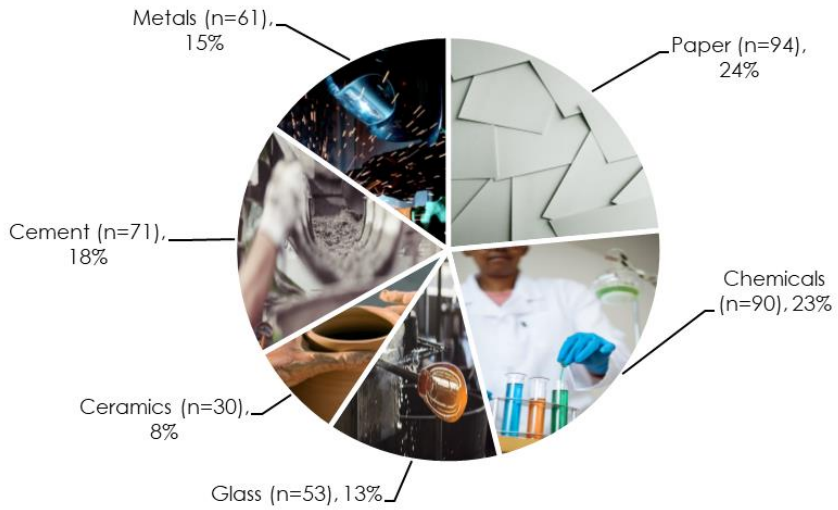
Key points on survey respondents

- For the majority of firms, over three quarters of their sales were to other businesses, which reflects the nature of FI as a supplier of key materials to other parts of the economy. Across all sectors, this proportion was higher for paper and chemicals, but much lower for ceramics.
- Turnover in the year up to March 2020 was lower for ceramics firms than other sectors, and higher for paper and chemicals. The levels of profits were relatively higher in glass and lower in metals and ceramics. The higher profitability in glass may depend on the capital employed. The results on turnover and profitability in ceramics may reflect the larger proportion of micro businesses in this sector.
- Around half of the firms had exported goods or services in the year up to March 2020. The proportion of exporters was higher among firms that had invested in R&D or innovation, and among those that had invested in new technologies or processes.
- There was a relatively higher proportion of foreign owned companies within cement and chemicals, compared with the average across all FI.
- Just over half of all firms had an equality, diversity and inclusion (EDI) plan or strategy in place. The proportion of firms with an EDI strategy was relatively higher in cement and chemicals, but much lower in ceramics (reflecting the large proportion of micro firms in ceramics). Large and medium-sized firms were more likely to have EDI strategies than micro or small businesses.

Sectors

2.7 Figure 2-1 shows the proportion of the different FI sectors in the survey according to those who responded to the survey. Around a quarter of all survey participants were operating within the paper sector and a similar proportion in chemicals (24% and 23%, respectively), followed by cement (18%), metals (15%), glass (13%) and ceramics (8%).

Figure 2-1: Sectors of survey respondents

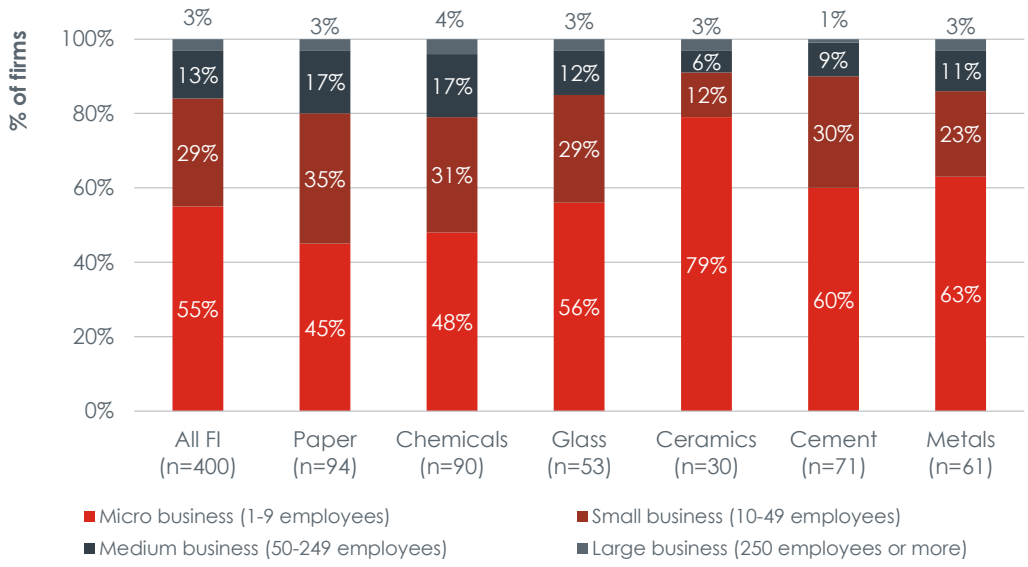


Source: SQW analysis of business survey
Base: All survey participants (n=400)

Size

2.8 Across all FI, the majority of firms were either micro (55%) or small businesses (29%) with up to 49 employees (Figure 2-2) (note this represents weighted data, as do all subsequent charts and tables). Compared to other FI, ceramics had a relatively higher proportion of micro businesses, accounting for over three quarters of the sector total. Note that, as explained at the start of this section, results in the chart below are presented for the FI as a whole and then each sector is compared against the FI rather than shown as part of the FI.

Figure 2-2: How many employees did your business have on the payroll at the end of March 2020?

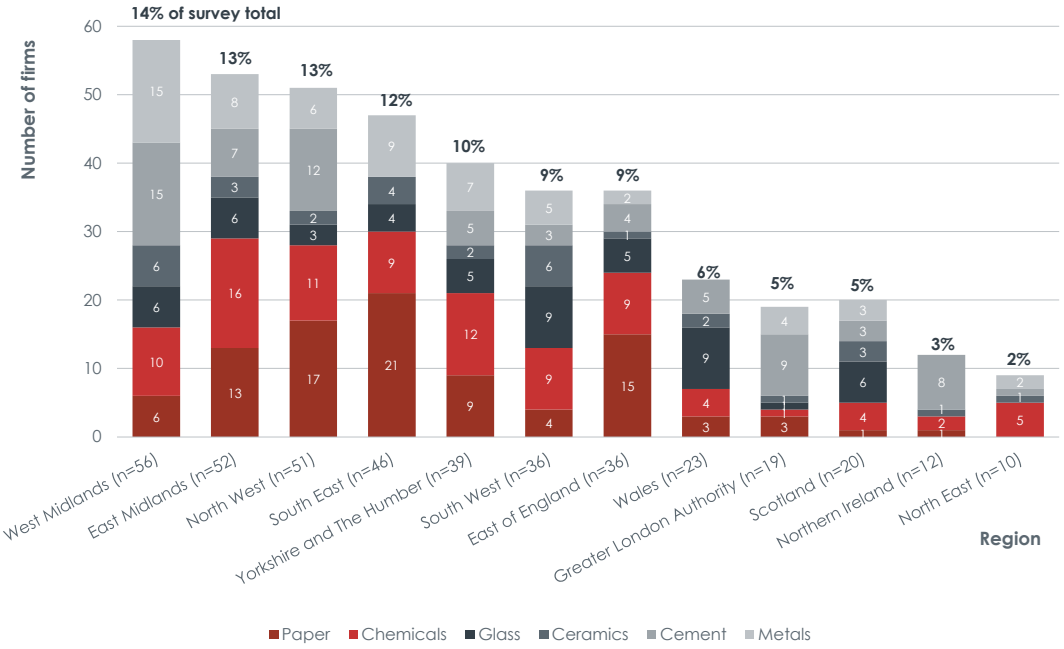


Source: SQW analysis of business survey
Base: All survey participants (n=400)

Location

2.9 Figure 2-3 shows the breakdown of survey participants by region. Just over a quarter of all firms (27%) were in the Midlands, followed by the North West (13%), the South East (12%), Yorkshire and the Humber (10%), the South West (9%) and the east of England (9%).

Figure 2-3: What is the postcode of your business's main UK site (HQ)?



Source: SQW analysis of business survey
Base: All survey participants (n=400)

Ownership and age

2.10 The majority (84%) of firms were UK-owned with no overseas operations (Table 2-2). There was a relatively higher proportion of foreign owned companies within cement (21%) and chemicals (18%), compared with the average of 12% across all FI.

Table 2-2: Is your business UK-owned with no overseas operations, UK-owned with overseas subsidiaries, or foreign owned?[4]

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
UK-owned with no overseas operations	86%	80%	93%	95%	77%	82%	**84%**
UK-owned with overseas subsidiaries	6%	2%	1%	1%	2%	4%	**3%**
Foreign owned	8%	18%	5%	2%	21%	12%	**12%**
Part foreign / part UK-owned	0%	0%	0%	2%	0%	2%	**1%**

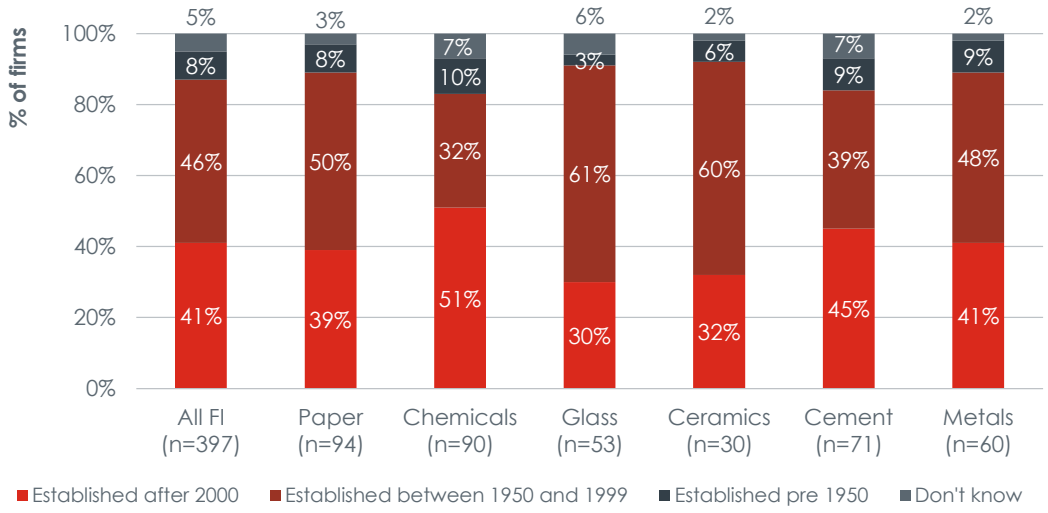
[4] It was not possible to establish the proportion of turnover from the UK operations of a business because of data availability. Therefore the scale of overseas ownership may be masked.

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
Don't know	0%	1%	0%	0%	0%	0%	***0%**
Total no. of firms	**94**	**90**	**53**	**30**	**71**	**61**	**400**

Source: SQW analysis of business survey
Base: All survey participants (n=400)
**Note, totals may not sum correctly due to rounding errors.*

2.11 Around half (46%) of all firms were established between 1950 and 1999, though the proportion of this was relatively higher within glass and ceramics (61% and 60% of the sectors, respectively). A further 41% were established after 2000 (Figure 2-4).

Figure 2-4: In which year was your business / your parent business first established?



Source: SQW analysis of business survey
Base: All survey participants (n=397)

Financial performance

Turnover

2.12 In the 12 months up to March 2020, turnover varied across the firms from less than £100,000 to over £50 million (Table 2-3). Turnover was relatively lower in ceramics, with 76% of firms reporting turnover lower than £500,000 (cf. FI average of 37%). Conversely, a higher proportion of firms in paper and chemicals reported a turnover of over £500,000: 67% and 63%, respectively (cf. FI average of 57%).

Table 2-3: If you had to estimate the annual turnover of your business for the 12 months to the end of March 2020, what would it be?

	Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All FI (n=400)
Less than £100,000	5%	8%	11%	53%	7%	13%	**11%**
£100,000 - £500,000	21%	22%	31%	23%	33%	30%	**26%**
Over £500,000 up to £2m	25%	21%	22%	9%	9%	25%	**20%**
Over £2m up to £10m	22%	21%	9%	7%	13%	15%	**16%**
Over £10m up to £50m	14%	13%	14%	3%	26%	9%	**15%**
£50m+	6%	8%	4%	4%	5%	4%	**6%**
Don't know	3%	1%	3%	2%	7%	2%	**3%**
Refused	5%	6%	6%	0%	0%	2%	**4%**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

2.13 For the majority of firms (71%), over three quarters of their sales were to other businesses, which reflects the nature of FI as a supplier of key materials to other parts of the economy (Table 2-4). Across all sectors, this proportion was higher for paper and chemicals (mean percentage scores of 92 and 90, respectively, cf. 82 across all FI) but much lower for ceramics (mean percentage score of 47).

Table 2-4: Approximately what percentage of your business' sales are to other businesses?

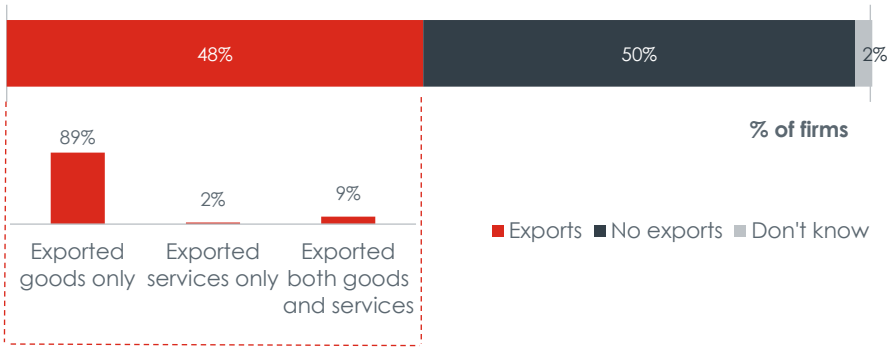
	Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All FI (n=400)
Up to 25%	3%	3%	9%	45%	12%	10%	**10%**
26% - 50%	2%	7%	13%	10%	4%	3%	**6%**
51% - 75%	8%	7%	9%	8%	24%	7%	**10%**
76% - 100%	85%	81%	66%	37%	54%	79%	**71%**
Don't know	2%	0%	3%	1%	7%	2%	**2%**
Refused	2%	2%	0%	0%	0%	0%	**1%**
Mean percentage score	**92**	**89.9**	**78.2**	**46.9**	**76.3**	**84.9**	**82.4**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

Exports

2.14 Around half of the firms had exported goods or services in the year up to March 2020 (Figure 2-5). The majority of exports were for goods with only 11% exporting any services (though this is slightly higher than the average of 8% across all UK manufacturing firms).[5]

Figure 2-5: In the year up to March 2020, did your business export any goods or services outside of the UK? / Roughly what percentage of your turnover was accounted by exports of goods and/or services?



Source: SQW analysis of business survey
Base: All survey participants (n=400)

2.15 Table 2-5 shows the breakdown of export activity by sector. Across the FI, the proportion of exporters was relatively lower in metals and cement with around a third of the firms exporting (34% and 30%, respectively) but higher in chemicals (64%).

Table 2-5: In the year up to March 2020, did your business export any goods or services outside of the UK? – By sector

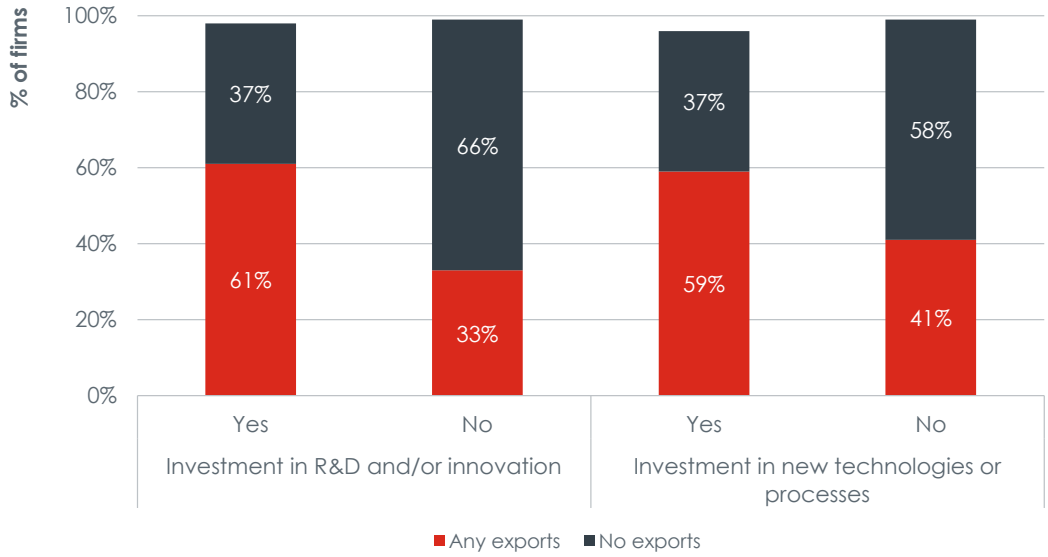
	Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All FI (n=400)
Exported goods only	50%	56%	43%	44%	30%	26%	**43%**
Exported services only	2%	2%	1%	2%	0%	0%	**1%**
Exported both goods and services	6%	6%	3%	2%	0%	8%	**5%**
No exports	41%	36%	51%	53%	64%	66%	**50%**
Don't know	2%	0%	1%	0%	7%	0%	**2%**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

[5] Annual Business Survey 2019.

2.16 Figure 2-6 shows the breakdown of exporting status by innovation activity, indicating that **the proportion of exporters was higher among firms that had invested in R&D or innovation** (61% of those that had cf. 33% of those that had not), **and those that had invested in new technologies or processes** (59% cf. 41%).

Figure 2-6: Exporting status by innovation activity



Source: SQW analysis of business survey
Base: All survey participants that indicated exporting status and either investment in R&D/innovation (n=394) or investment in new technologies or processes (n=396)

2.17 For the majority of firms (73%), the exports of goods accounted for up to half of their total turnover (Table 2-6). Services accounted for up to a quarter of total turnover for two thirds of the firms that had exported any services.[6]

[6] The results for percentage of turnover accounted for by exports of services is not presented as a table because of a low number of responses (n=23).

Table 2-6: Roughly what percentage of your turnover was accounted by exports of goods?

	Paper (n=53)	Chemicals (n=56)	Glass (n=25)	Ceramics (n=14)	Cement (n=21)	Metals (n=21)	All FI (n=189)
Up to 25%	53%	67%	65%	61%	40%	58%	**58%**
Between 26% and 50%	11%	16%	16%	17%	25%	8%	**15%**
Between 51% and 75%	19%	8%	13%	5%	35%	17%	**16%**
Between 76% and 100%	14%	6%	0%	5%	0%	12%	**7%**
Don't know	3%	2%	7%	12%	0%	5%	**3%**
Refused	0%	2%	0%	0%	0%	0%	***0%**

Source: SQW analysis of business survey
Base: All survey participants that exported any goods (n=189)
**Note, totals may not sum correctly due to rounding errors.*

Costs

2.18 For just under half of the firms (45%), business costs were up to £500,000 in the year to March 2020 (Table 2-7). Costs were relatively lower in ceramics with 60% of firms saying their annual business costs were less than £100,000 (cf. average of 18% across all FI).This reflects the size of businesses in ceramics (i.e. larger proportion of micro businesses). On the other hand, costs for cement businesses were higher with 50% reporting costs of over £500,000 (cf. FI average of 39%).

Table 2-7: If you had to estimate the annual costs of your business for the 12 months to the end of March 2020, what would it be?

	Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All FI (n=400)
Less than £100,000	11%	14%	20%	60%	13%	19%	**18%**
£100,000 - £500,000	25%	25%	32%	17%	28%	33%	**27%**
Over £500,000 up to £2m	25%	17%	16%	6%	27%	18%	**20%**
Over £2m up to £10m	6%	15%	12%	2%	12%	13%	**11%**
Over £10m up to £50m	9%	9%	1%	3%	11%	10%	**8%**
£50m+	6%	7%	8%	0%	1%	1%	**4%**
Don't know	8%	3%	7%	9%	7%	1%	**5%**
Refused	9%	11%	3%	3%	1%	4%	**6%**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

Profit

2.19 For around half of the firms (55%), profitability was lower than £500,000 in the year to March 2020 (Table 2-8). Firms were relatively more profitable in the glass sector with 23% of firms reporting a profit of over £500,000 (cf. average of 15% across all FI) but were less profitable in metals (9%) and ceramics (7%). The results for ceramics can largely be explained by the larger proportion of micro businesses in this sector.

Table 2-8: If you had to estimate the annual operating profit of your business for the 12 months to the end of March 2020, what would it be?

	Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All FI (n=400)
Less than £100,000	30%	35%	31%	56%	24%	34%	**33%**
£100,000 - £500,000	31%	29%	12%	6%	18%	22%	**22%**
Over £500,000 up to £2m	3%	9%	8%	3%	10%	4%	**7%**
Over £2m up to £10m	8%	2%	8%	0%	3%	2%	**4%**
Over £10m up to £50m	2%	1%	7%	1%	1%	2%	**2%**
£50m+	2%	4%	0%	3%	0%	1%	**2%**

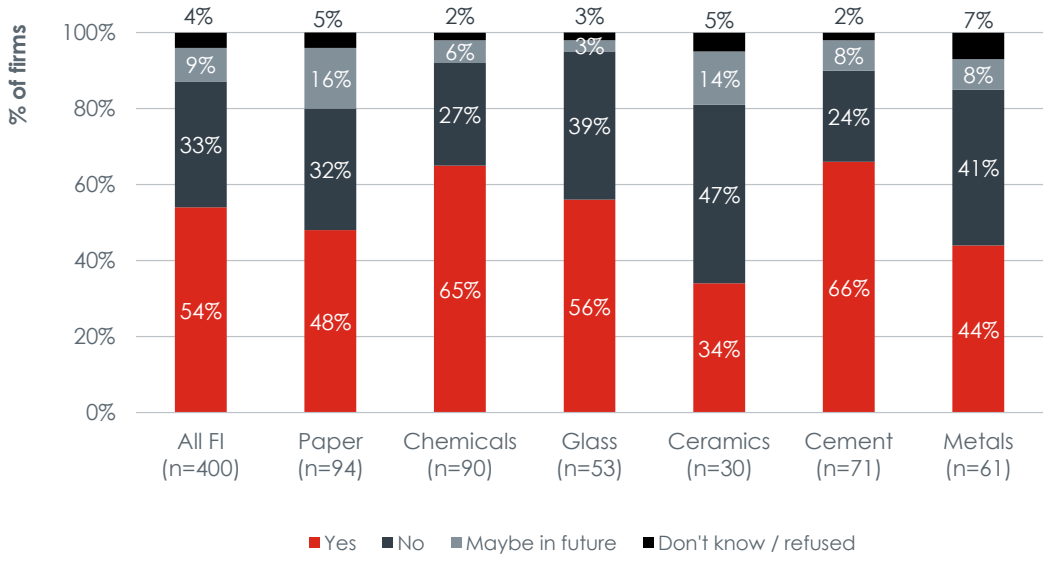
	Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All FI (n=400)
Made a loss	0%	3%	4%	2%	0%	7%	**2%**
Don't know	19%	11%	29%	29%	45%	28%	**25%**
Refused	6%	6%	0%	0%	0%	0%	**3%**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

Equality, diversity & inclusion

2.20 Just over half of all firms (54%) had an equality, diversity and inclusion (EDI) plan or strategy in place (Figure 2-7). Of the firms that did not, one in five would consider introducing a plan in the future. The proportion of firms with an EDI strategy was relatively higher in cement (66%) and chemicals (65%), but much lower in ceramics (34%). For ceramics, this is likely to be due to presence of micro companies.[7] In terms of firm size, large firms were most likely to have an EDI strategy (89%), compared with micro- (45%), small- (60%) or medium-sized (76%) businesses.

Figure 2-7: Does your business have an equality, diversity and inclusion plan or strategy in place?



Source: SQW analysis of business survey
Base: All survey participants (n=400)

[7] There is evidence to suggest micro/small businesses tend not to have formal EDI plans/ strategies compared to larger firms. For example, see: FSB (2020) Unlocking Opportunity: The Value Of Ethnic Minority Firms To UK Economic Activity And Enterprise: https://www.enterpriseresearch.ac.uk/wp-content/uploads/2020/07/Unlocking-Opportunity_FSB-Report-.2020.pdf; and BBB (2020) Alone, together - Entrepreneurship and diversity in the UK: https://www.british-business-bank.co.uk/wp-content/uploads/2020/10/Alone-together-Entrepreneurship-and-diversity-in-the-UK-FINAL.pdf

3. Business survey findings

3.1 This section provides insights on: how businesses within the Foundation Industries perceive the FI, attitudes to innovation, innovation activity, collaboration, skills and net zero. The analysis in this section uses weighted data.

Summary

The businesses surveyed did not recognise the ceramics, glass, cement, metals, paper and chemicals sectors as 'Foundation Industries', and it was inconclusive whether businesses considered themselves as being part of FI. This perhaps suggests the need to develop a shared FI 'identity' – a key aim of TFI ISCF (Workstream 4).

In the financial year 2019/20, investment in R&D and/or innovation[8] was undertaken by just over a half of the businesses across FI. The majority of businesses in chemicals (73%), cement (62%) and glass (54%) invested in R&D and/or innovation: a smaller proportion of businesses did so in paper (49%), metals (32%) and ceramics (31%). In terms of business size, most small (65%), medium (82%) and large businesses (81%) invested in R&D and/or innovation, but this was much lower for micro-businesses (39%).

Businesses invested mostly in internal R&D and/or innovation (95%), acquisition of advanced machinery/equipment/software (59%), and training for R&D and/or innovation activities (46%). The investment covered a wide range from less than £50k to more than £5m – almost three quarters of businesses invested under £250k. There was no major variation between sectors with the exception of ceramics, where around three quarters of firms invested less than £50k (reflecting mostly micro businesses). A small proportion of businesses in chemicals, metals, paper and glass invested over £1m (3% to 6%). There was little evidence of foreign direct investment (FDI) for R&D and/or innovation (less than 10%). However, for a small proportion of companies in chemicals, ceramics and metals (7% each), between 75% and 100% of their investment was from FDI.

[8] No definition of R&D and/or innovation was presented to survey respondents in order to keep the completion time as quick as possible. If queried, we would offer something along the following lines, which is an OECD definition adopted by Eurostat. This definition includes any of the following activities: 1. The introduction of a new or significantly improved product (good or service) or process; 2. Engagement in innovation projects not yet complete, scaled back, or abandoned; 3. New and significantly improved forms of organisation, business structures or practices, and marketing concepts or strategies; 4. Investment activities in areas such as internal research and development, training, acquisition of external knowledge or machinery and equipment linked to innovation activities.

The most common perceived barriers to R&D and/or innovation reported by businesses were (in order): lack of time to invest, financial risk, lack of information on private funding, cost competition from abroad, standards and regulations, lack of technical and/or innovation skills, reluctance to collaborate with other companies in FI. Only 11% of businesses did not perceive any barriers to R&D and/or innovation. Interestingly, businesses that had invested in R&D and/or innovation were more likely to perceive barriers to R&D/innovation than companies that had not invested, particularly in terms of skills, reluctance to collaborate and technical risk.

In the financial year 2019/20, over half (55%) of businesses introduced new or significantly improved products and just under half (49%) introduced new or significantly improved processes. Chemicals businesses were most likely to have introduced new or significantly improved products (73%) and metals were least likely (35%). Cement was most likely to have introduced new or significantly improved processes (66%), and ceramics were least likely (32%).

The vast majority of businesses (85%) reported that new or significantly improved products or service innovations were new to their business, and nearly half were reported as new to the market. This was fairly consistent by sector. A similar picture emerges for new or significantly improved processes.

Most companies with an updated business plan invested in R&D and/or innovation compared to companies that did not have a business plan (82% compared to 48%). Similarly, the majority of companies that invested in new technologies or processes to improve energy and/or resource efficiency have a business plan, more than double compared to those that have not invested (65% versus 30%). However, the majority of companies without a business plan were micro-businesses (80%). Around two thirds (68%) of companies with a business plan have actions relating to R&D and/or innovation. This is highest in cement and chemicals (both 79%) and lowest among metals (53%).

In terms of collaborations, around one-third of businesses worked with other organisations to develop new products, services or processes. Cement, ceramics, paper and metals were least collaborative. Collaboration increased by size of business, especially for medium and large businesses (this is broadly in line with the results from the 2021 ERC survey of UK FI). Collaboration activity was most common with other businesses- there was no difference overall between collaboration with businesses in the same or different sector (62% each). Importantly, there appears to be much lower levels of collaboration with universities (23%) and other research institutes (11%).

Most businesses agreed that their senior management team recognise the importance of the Government's net zero agenda - and recognise the importance of innovation within their firm to working towards net zero. Around half of businesses reported that their

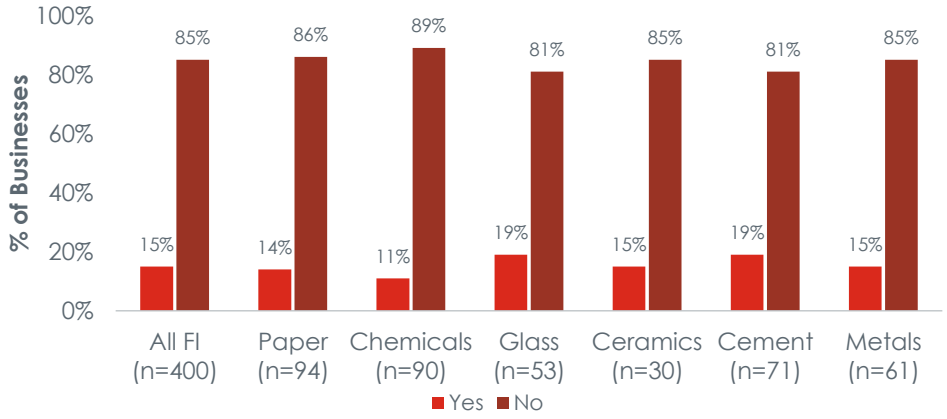
senior management had taken action to improve both energy and resource efficiency. This was highest in chemicals, glass, and metals. The most common reasons to improve energy and/or resource efficiency related to cutting costs and business commitment to the net zero agenda. Just over a quarter of all firms had invested in new technologies or processes to improve both energy and resource efficiency.

The majority of businesses (88%) reported that between 76% and 100% of their staff were fully proficient at their job. This was fairly consistent across all sectors. Approximately two thirds of businesses did not have any vacancies that were proving hard to fill because applicants did not have the right skills. Finally, businesses struggled to find technical and/or innovation skills in job applicants or existing staff – this was consistent across all six sectors.

Perceptions of Foundation Industries

3.2 The large majority of firms had not heard of the ceramics, glass, cement, metals, paper and chemicals sectors being described as 'Foundation Industries' (Figure 3-1). Across each of the sectors, the proportion of firms which had not heard of the sectors as being described as FI was relatively consistent. This suggests there is the need for developing an FI 'identity', something which ISCF is aiming to deliver through Workstream 4 'Establishing the foundation industries as a sector'.

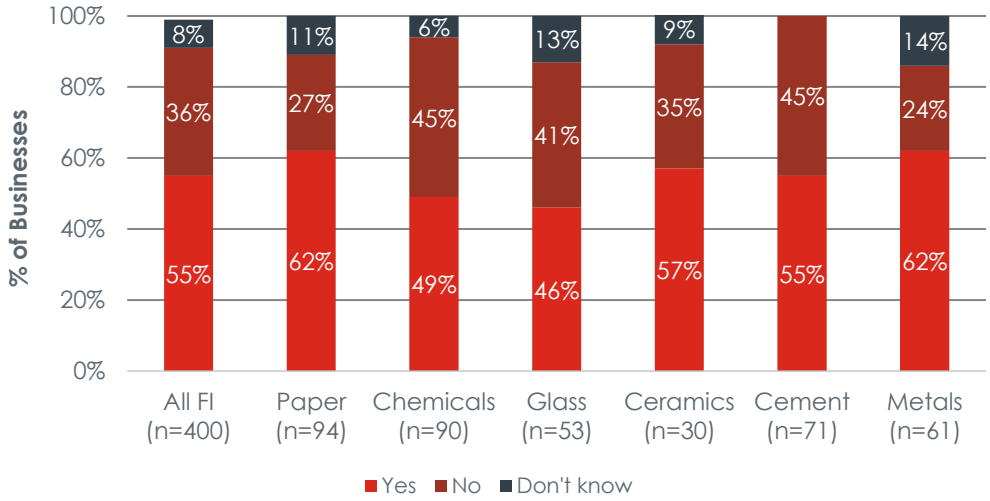
Figure 3-1: Have you ever heard of the ceramics, glass, cement, metals, paper and chemicals sectors being described as 'Foundation Industries'?



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.3 Although the majority of firms had not heard of the sectors being described as FI most considered themselves as part of FI but over one-third did not (Figure 3-2). This may suggest firms would be receptive to the TFI Challenge's aim to establish the FI as a sector through developing a shared identity amongst businesses.

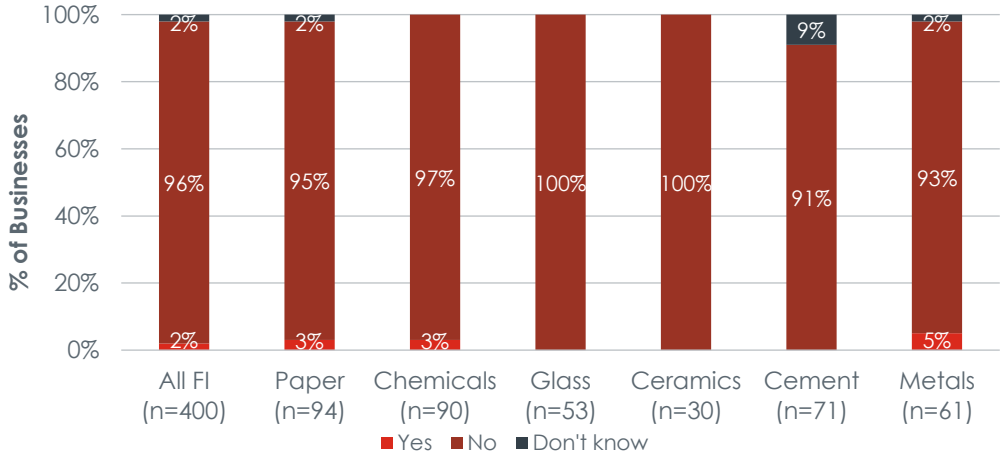
Figure 3-2: Would you consider your business to be part of the Foundation Industries?



Source: SQW analysis of business survey
Base: All survey participants (n=400)
Note, totals may not sum correctly due to rounding errors.

3.4 Across all FI, the majority of businesses had not participated in the TFI ISCF in any way (Figure 3-3), for example through reading TFI material, applying to TFI competitions or attending TFI events. This is expected given the programme has only just begun its second year and the survey sampled the entire FI.

Figure 3-3: Has your business participated in the TFI ISCF in any way?



Source: SQW analysis of business survey
Base: All survey participants (n=400)
**Note, totals may not sum correctly due to rounding errors.*

3.5 For the small proportion of businesses that had participated in the TFI ISCF, this predominantly involved reading TFI materials (e.g., articles, perspectives, newsletters) and applying to a TFI competition (Table 3-1).

Table 3-1: Can you confirm which of the following activities your business has been involved in with the TFI ISCF?

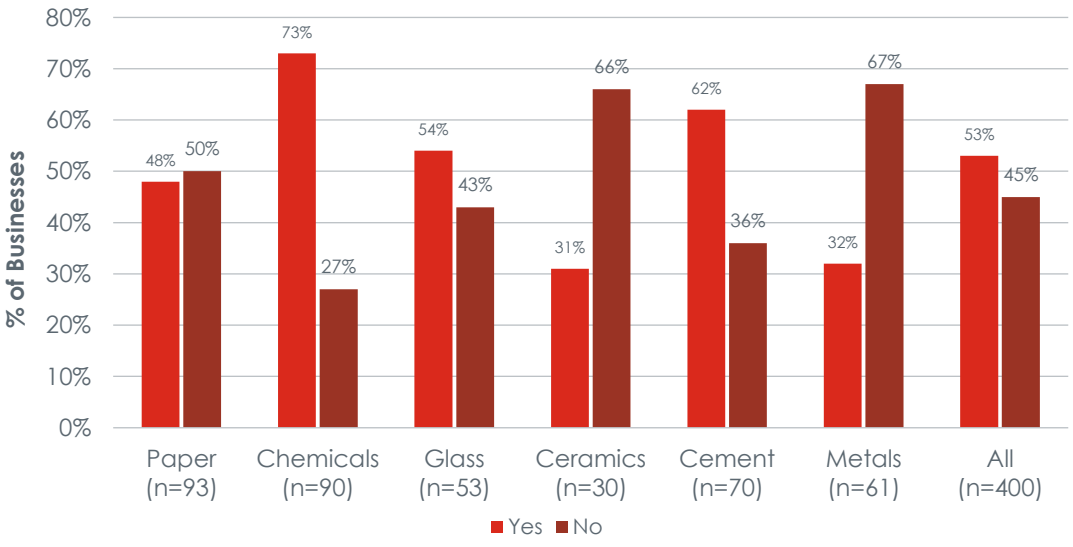
	Paper	Chemicals	Metals	Total
Read TFI material e.g. articles, perspectives, newsletters	1	2	1	**5**
Applied to a TFI competition	1	1	1	**4**
Attended a TFI event	1	0	1	**2**
Any other TFI activity	0	1	0	**1**
Don't know/can't recall	2	0	1	**2**
Total number of firms	**3**	**2**	**3**	**8**

Source: SQW analysis of business survey

Innovation attitudes and activity

3.6 Across the FI, just over a half of businesses had invested in R&D and/or innovation in the financial year April 2019 to March 2020 (Figure 3-4). The chemicals sector had the highest percentage of businesses investing in R&D and/or innovation (nearly three quarters). This was followed by (in order): cement, glass, paper, metals and ceramics.

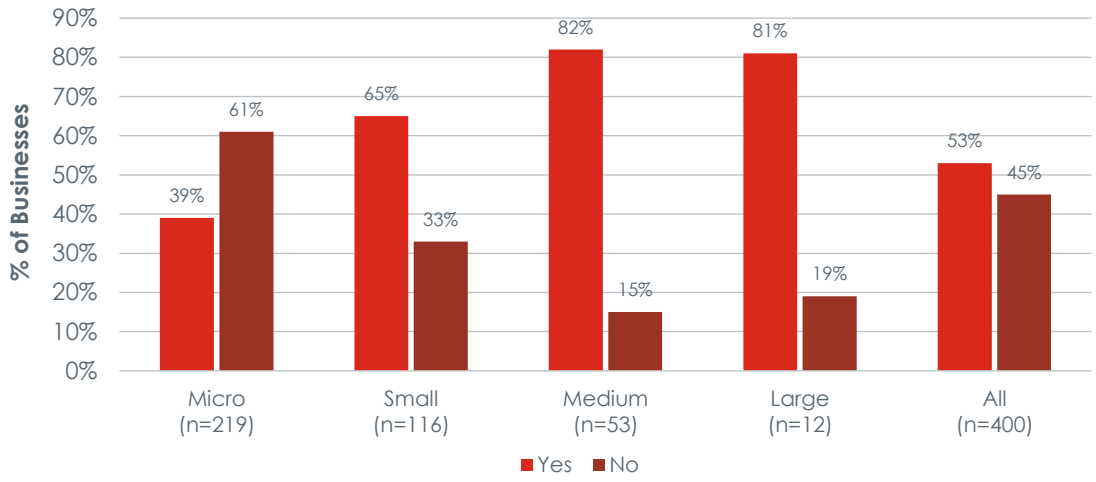
Figure 3-4: Did your business invest in R&D and/or innovation in the financial year April 2019 to March 2020? By sector



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.7 Investment in R&D and/or innovation from April 2019 to March 2020 was undertaken by the majority of small, medium and large businesses. In contrast, a minority (just under two-fifths) of micro businesses invested in R&D and/or innovation.

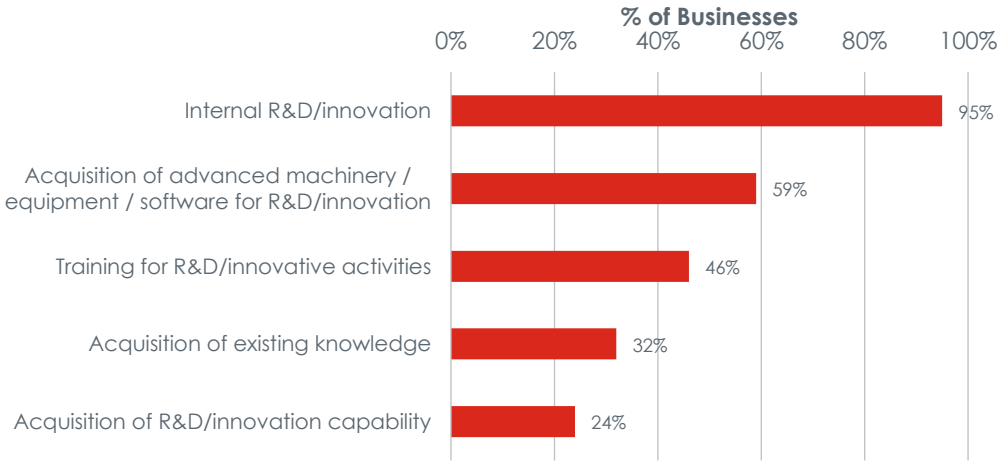
Figure 3-5: Did your business invest in R&D and/or innovation in the financial year April 2019 to March 2020? By size



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.8 Most businesses had invested in internal R&D and/or innovation; acquisition of advanced machinery/equipment/software; and training activities (Figure 3-6).

Figure 3-6: Which of the following did your business invest in during April 2019 to March 2020 (n=213)



Source: SQW analysis of business survey
Base: All survey participants that invested in R&D/innovation (n=213)

3.9 Business investment in R&D covered a wide range from less than £50k to more than £5m. Almost three quarters (74%) of businesses invested less than £250k and around two-fifths (38%) of businesses invested less than £50k. The average (mean) value of investment by sector suggests outliers in metals, paper and possibly chemicals.

Figure 3-7: If you had to estimate the value of R&D investment by your business from April 2019 to March 2020, how much do you think that would be? (n=213)

Source: SQW analysis of business survey
Base: All survey participants that invested in R&D/innovation (n=213)

Table 3-2: Average (mean) R&D investments by sector

Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
£2,684,761	£869,335	£256,455	£138,037	£190,336	£3,004,515	£1,145,778

Source: SQW analysis of business survey

3.10 There is some variation between sectors by level of investment - a small proportion of firms in chemicals, metals, paper and glass invested over £1m (between 3% and 10% from each of these sectors).

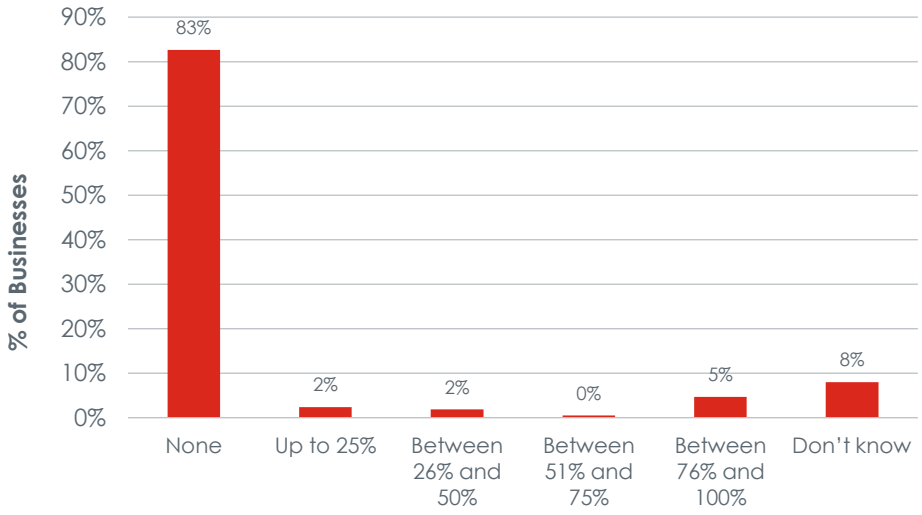
Table 3-3: If you had to estimate the value of R&D investment by your business from April 2019 to March 2020, how much do you think that would be? By sector

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
Less than £50,000	29%	39%	49%	74%	30%	38%	38%
£50,000 to £100,000	23%	28%	19%	12%	21%	32%	24%
Over £100,000, up to £250,000	13%	10%	11%	0%	20%	9%	12%
Over £250,000 up to £500,000	13%	4%	5%	9%	6%	11%	7%
Over £500,000 up to £1 million	10%	3%	11%	5%	12%	0%	7%
Over £1 million up to £2 million	0%	3%	3%	0%	1%	5%	2%
Over £2 million up to £5 million	3%	0%	0%	0%	0%	0%	1%
More than £5 million	3%	5%	0%	0%	0%	5%	3%
Don't know	3%	5%	3%	0%	11%	0%	5%
Refused	3%	3%	0%	0%	0%	0%	1%
Total firms	**45**	**66**	**29**	**9**	**44**	**20**	**213**

Source: SQW analysis of business survey
Base: All survey participants that invested in R&D/innovation (n=213)

3.11 Of the companies that invested in R&D and/or innovation, less than 10% involved foreign direct investment (Figure 3-8). However, for a small proportion of companies in chemicals, ceramics and metals (7% each), between 75% and 100% of their investment was from FDI (Table 3-4). There does not seem to be any pattern between the size of firm and proportion of FDI for R&D/innovation (Table 3-5)

Figure 3-8: What proportion of this was foreign direct investment? (n=213)



Source: SQW analysis of business survey
Base: All survey participants that invested in R&D/innovation (n=213)

Table 3-4: What proportion of this was foreign direct investment? By sector

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
None	87%	79%	92%	92%	75%	80%	**83%**
Up to 25%	0%	5%	2%	0%	1%	2%	**2%**
Between 26% and 50%	0%	0%	0%	5%	6%	7%	**2%**
Between 51% and 75%	3%	0%	0%	0%	0%	0%	**0%**
Between 76% and 100%	0%	7%	3%	0%	7%	7%	**5%**
Don't know	10%	9%	3%	3%	11%	5%	**8%**
Total firms	**45**	**66**	**29**	**9**	**44**	**20**	**213**

Source: SQW analysis of business survey
Base: All survey participants that invested in R&D/innovation (n=213)

Table 3-5: What proportion of this was foreign direct investment? By Size

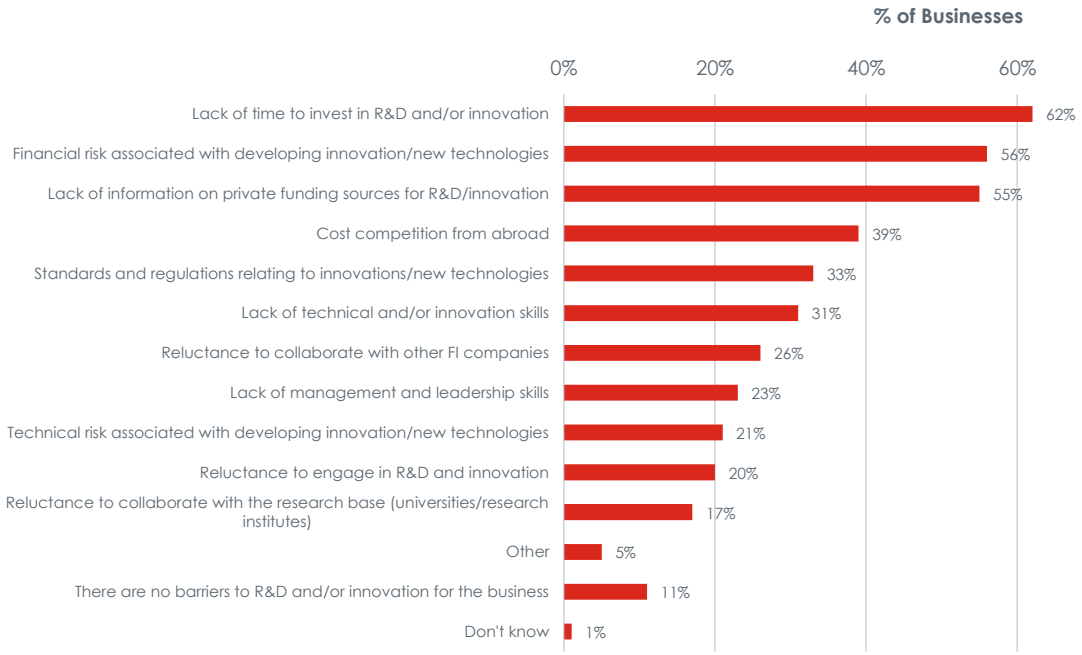
	Micro (n=85)	Small (n=75)	Medium (n=43)	Large (n=10)
None	88%	79%	85%	54%
Up to 25%	0%	4%	3%	4%
Between 26% and 50%	1%	4%	0%	9%
Between 51% and 75%	0%	2%	0%	0%
Between 76% and 100%	2%	6%	3%	18%
Don't know	10%	5%	9%	14%

Source: SQW analysis of business survey
Base: All survey participants that invested in R&D/innovation (n=213)

3.12 Businesses reported a wide range of perceived barriers to R&D and/or innovation.[9] These commonly included (in order): the lack of time to invest, financial risk, lack of information on private funding, cost competition from abroad, standards and regulations, lack of technical and/or innovation skills. Reluctance to collaborate with other companies in FI was also considered a perceived barrier, although this was not felt as strongly. Interestingly, only 11% of respondents did not perceive any barriers to R&D and/or innovation.

[9] The perceived barriers were prompted.

Figure 3-9: Which of the following, if any, do you perceive as barriers to research and development (R&D) and/or innovation for your business?



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.13 There was general consensus amongst businesses from different sectors on the perceived barriers to R&D and/or innovation i.e. there was not much variation between sectors in relation to particular barriers (Table 3-6).

Table 3-6: Which of the following, if any, do you perceive as barriers to research and development (R&D) and/or innovation for your business? (By sector)*

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
Lack of time to invest in R&D and/or Innovation	62%	60%	64%	64%	60%	64%	**62%**
Financial risk associated with developing innovation/new technologies	67%	63%	60%	63%	31%	53%	**56%**
Lack of information on private funding sources for R&D/innovation	56%	62%	58%	52%	47%	53%	**55%**
Cost competition from abroad	47%	33%	49%	31%	31%	42%	**39%**
Standards and regulations relating to innovations/new technologies	31%	33%	40%	30%	32%	36%	**33%**

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
Lack of technical and/or innovation skills	34%	38%	23%	26%	27%	32%	**31%**
Reluctance to collaborate with other FI companies	25%	31%	20%	24%	28%	26%	**26%**
Lack of management and leadership skills	20%	21%	23%	16%	33%	21%	**23%**
Technical risk associated with developing innovation/new technologies	28%	21%	29%	16%	14%	16%	**21%**
Reluctance to engage in R&D and innovation	27%	18%	8%	22%	21%	23%	**20%**
Reluctance to collaborate with the research base (universities/research institutes)	19%	16%	22%	19%	18%	12%	**17%**
Other	3%	7%	6%	13%	0%	4%	**5%**
There are no barriers to R&D and/or innovation for the business	13%	10%	7%	14%	7%	18%	**11%**
Don't know	2%	0%	2%	2%	0%	0%	**1%**
N	**94**	**90**	**53**	**30**	**71**	**61**	**400**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.14 Interestingly, those businesses that had invested in R&D and/or innovation were more likely to perceive barriers to R&D/innovation than companies that had not invested, perhaps because they have more experience of engaging in R&D and/or innovation and have experienced barriers (Table 3-7). While there were similar levels of identification of many barriers across business that had and had not invested, the following barriers were recognised by a noticeably higher proportion of business that had invested: lack of technical and/or innovation skills; lack of management and leadership skills; reluctance to collaborate with other FI companies; reluctance to collaborate with the research base (universities/research institutes); and technical risk associated with developing innovation/new technologies.

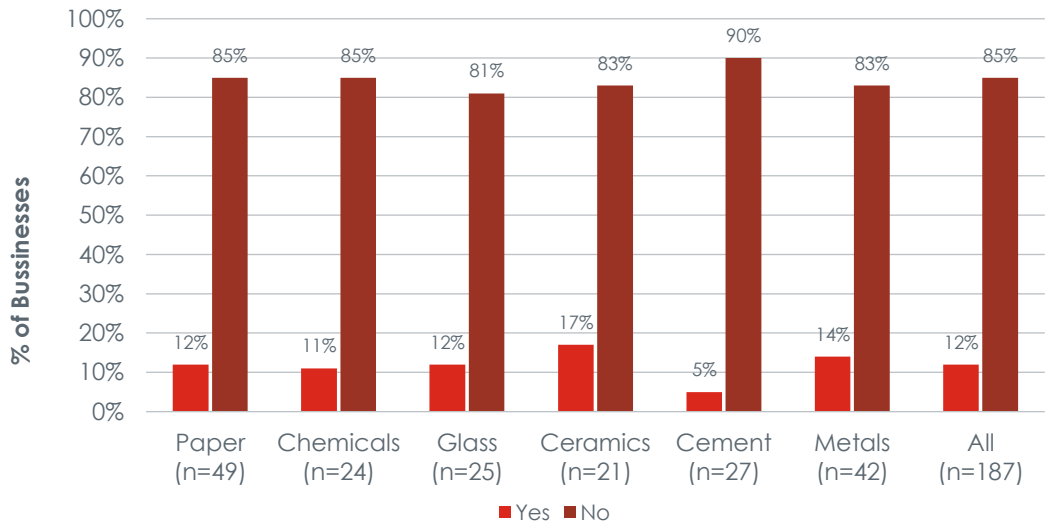
Table 3-7: Which of the following, if any, do you perceive as barriers to research and development (R&D) and/or innovation for your business? – By innovation activity

	Investment in R&D and/or innovation	
	Yes (n=213)	No (n=181)
Lack of time to invest in R&D and/or innovation	66%	58%
Financial risk associated with developing innovation/new technologies	63%	49%
Lack of information on private funding sources for R&D/innovation	61%	50%
Cost competition from abroad	38%	40%
Standards and regulations relating to innovations/new technologies	36%	31%
Lack of technical and/or innovation skills	39%	22%
Reluctance to collaborate with other FI companies	34%	18%
Lack of management and leadership skills	27%	18%
Technical risk associated with developing innovation/new technologies	29%	12%
Reluctance to engage in R&D and innovation	21%	19%
Reluctance to collaborate with the research base (universities/research institutes)	21%	13%
Other	3%	7%
There are no barriers to R&D and/or innovation for the business	4%	20%
Don't know	0%	1%

Source: SQW analysis of business survey
Base: All survey participants that responded 'yes' or 'no to investment in R&D and/or innovation (n=394), plus all survey participants that responded 'yes' or 'no to investment in new technologies or processes to improve energy and/or resource efficiency (n=396)

3.15 Figure 3-10 shows that a large majority of companies that had not invested in R&D and/or innovation during the last financial year had not even *considered* investing in R&D during the last financial year.

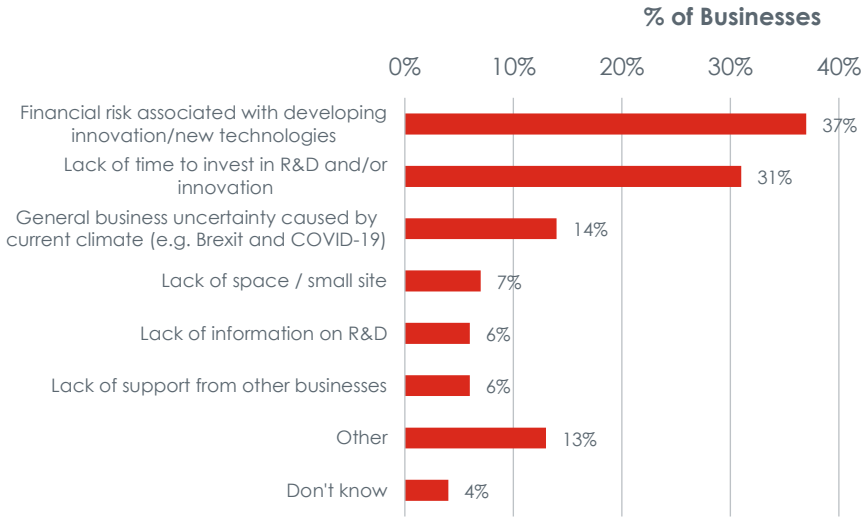
Figure 3-10: In the period April 2019 to March 2020, did you seriously consider investing in R&D? By sector



Source: SQW analysis of business survey
Base: All survey participants responding to the question" In the period April 2019 to March 2020, did you seriously consider investing in R&D?" (n=187)

3.16 Of those companies that had seriously considered investment in R&D and/or innovation but decided not to invest, the top three reasons related to: financial risk, lack of time to invest, and general business uncertainty caused by the current climate (e.g. Brexit). However, these figures are based on a small number of survey responses and should be interpreted with caution (Figure 3-11).

Figure 3-11: Why did you decide not to invest? (n=22)



Source: SQW analysis of business survey
Base: All survey participants who considered investment in R&D/innovation but did not invest (n=22)

3.17 Of those businesses that had not considered investment in R&D and/or innovation, a third cited a lack of need due to the nature of the business (Table 3-8).

Table 3-8: Why did you not seriously consider investing in R&D? By sector

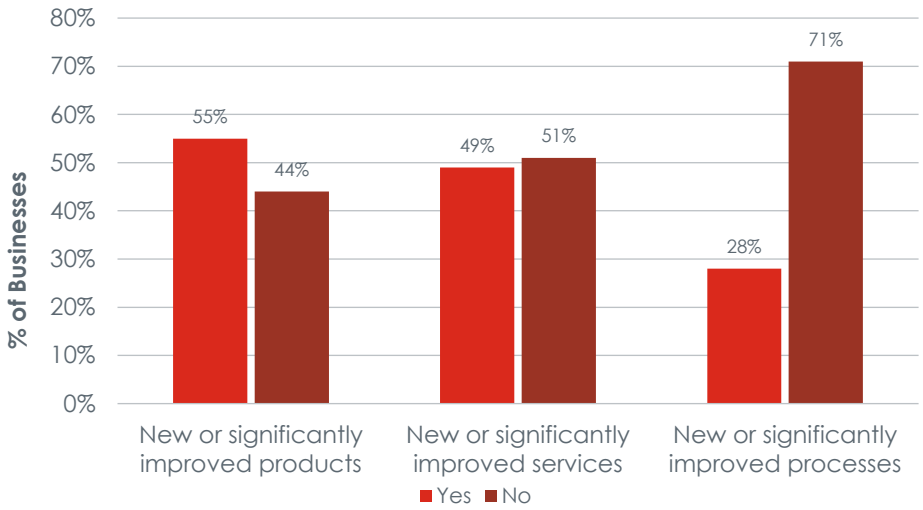
	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
R&D not needed due to nature of the business (e.g. traditional trade)	36%	35%	19%	43%	30%	35%	**33%**
Lack of time to invest in R&D and/or innovation	11%	17%	30%	19%	30%	16%	**19%**
Financial risk associated with developing innovation/new technologies	14%	26%	11%	21%	0%	17%	**14%**
Never thought about it / considered it	4%	9%	4%	3%	20%	14%	**9%**
Size / maturity of business	11%	4%	8%	8%	11%	8%	**9%**
General business uncertainty caused by current climate (e.g. Brexit and the COVID-19 pandemic)	4%	4%	11%	0%	0%	5%	**4%**
Business owners approaching retirement	4%	0%	4%	11%	0%	6%	**4%**
Lack of management and leadership skills	4%	0%	4%	0%	0%	1%	**2%**
Reluctance to engage in R&D and innovation	0%	0%	4%	0%	0%	3%	**1%**
Lack of technical and/or innovation skills	0%	0%	0%	0%	0%	3%	**1%**
Standards and regulations relating to innovations/new technologies	0%	0%	0%	0%	0%	3%	**1%**
Technical risk associated with developing innovation/new technologies	0%	0%	0%	0%	0%	1%	**%**
Other	11%	18%	7%	6%	0%	7%	**8%**
Don't know	7%	4%	11%	8%	20%	0%	**8%**
N	**42**	**20**	**20**	**18**	**24**	**34**	**158**

Source: SQW analysis of business survey
Base: All survey participants who did not consider investment in R&D/innovation (n=158)

3.18 Over half (55%) of FI companies introduced new or significantly improved products from April 2019 to March 2020 and just under (49%) introduced new or significantly improved processes, indicating a reasonable level of innovation. Chemicals companies were most likely to have introduced new or significantly improved products (73%) and metals were least

likely (35%). Cement companies were most likely to have introduced new or significantly improved processes (66%) and ceramics the least (32%) (see Table 3-9).

Figure 3-12: In the financial year April 2019 to March 2020, did your business introduce any of the following?



Source: SQW analysis of business survey
Base: All survey participants (n=400)

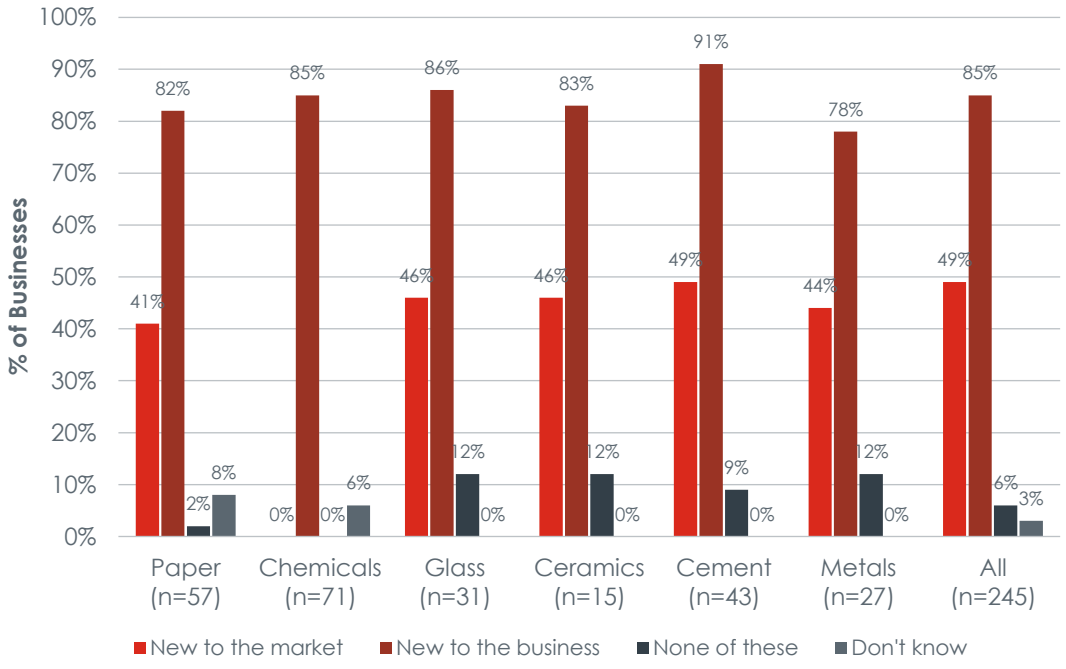
Table 3-9: In the financial year April 2019 to March 2020, did your business introduce any of the following? By sector

		Paper (n=94)	Chemicals (n=90)	Glass (n=53)	Ceramics (n=30)	Cement (n=71)	Metals (n=61)	All (n=400)
New or significantly improved products	Yes	55%	72%	50%	41%	61%	35%	**55%**
	No	44%	28%	50%	55%	39%	65%	**44%**
New or significantly improved services	Yes	27%	34%	27%	24%	24%	31%	**28%**
	No	73%	66%	73%	70%	76%	69%	**71%**
New or significantly improved processes	Yes	41%	56%	51%	32%	66%	39%	**49%**
	No	59%	44%	49%	68%	34%	61%	**51%**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

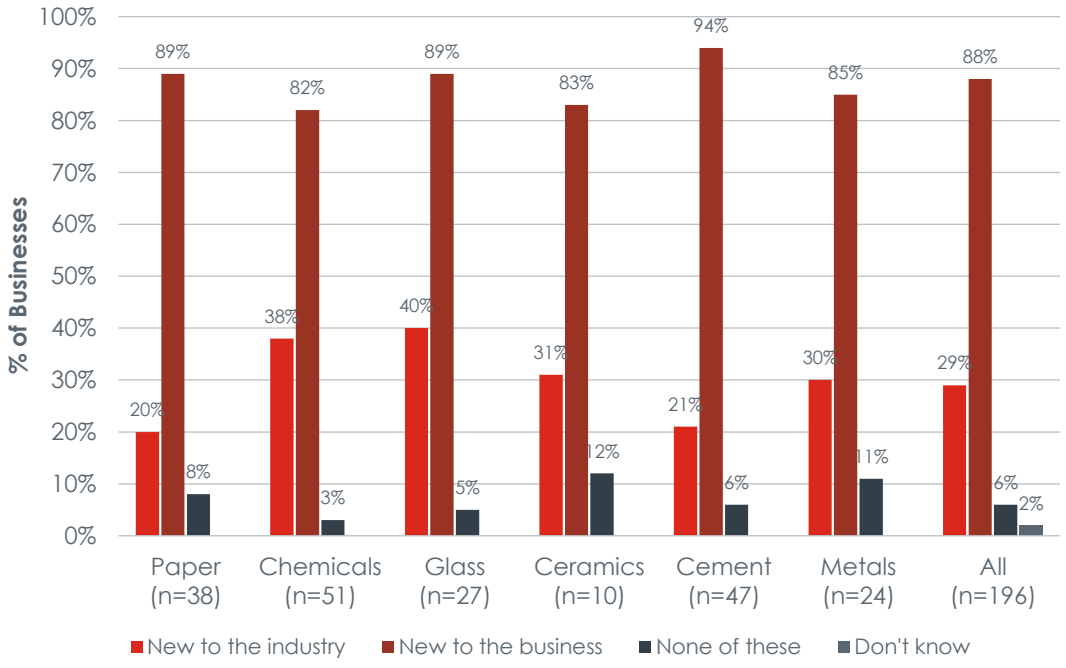
3.19 The vast majority of businesses reported that new or significantly improved products or service innovations were new to their business, but nearly half were reported as new to the market. This is fairly consistent by sector. A similar picture emerges for new or significantly improved processes – most were new to the business rather new to their industry.

Figure 3-13: Were any of these new or significantly improved products or service innovations new to the market, or new to your business? By sector



Source: SQW analysis of business survey
Base: All survey participants excluding those respondents who did not indicate that they had introduced new or improved product or service innovations (n=245)

Figure 3-14: Were any of these new or significantly improved processes new to your industry, or were they new to your business? By sector



Source: SQW analysis of business survey
Base: All survey participants excluding those respondents who did not indicate that they had introduced new or improved processes (n=196)

3.20 The majority of companies have a business plan (66%), but a large minority have a plan that was updated (44%) (Table 3-10). Chemicals had the highest proportion of companies with an updated business plan (56%) and glass had the lowest (27%). Almost half of the ceramics sector (45%) did not have a business plan.

Table 3-10: Which of the following best describes your company's business plan?

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	Total
My company has a business plan, and it was updated in the financial year April 2019 to March 2020	47%	56%	27%	31%	53%	37%	**44%**
My company has a business plan, but it was not updated in the financial year April 2019 to March 2020	23%	22%	31%	20%	14%	20%	**22%**
My company does not have a business plan	27%	21%	39%	45%	33%	43%	**32%**
Don't know	2%	1%	3%	3%	0%	1%	**1%**
Refused	2%	0%	0%	0%	0%	0%	**0%**
Total	**94**	**90**	**53**	**30**	**71**	**61**	**400**

Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.21 Most companies with an updated business plan also invested in R&D and/or innovation compared to companies that did not have a business plan (82% compared to 48%, see Table 3-11).

Table 3-11: Which of the following best describes your company's business plan? – by R&D investment

	Had invested R&D/innovation (n=213)	Had not invested R&D/innovation (n=181)
My company has a business plan, and it was updated in the financial year April 2019-March 2020	61%	25%
My company has a business plan, but it was not updated in the financial year April 2019-March 2020	21%	23%
My company does not have a business plan	18%	50%
Don't know	0%	2%
Refused	0%	1%

Source: SQW analysis of business survey
Base: All survey participants excluding those respondents who said 'Don't know' to the question whether they had invested in R&D/innovation (n=394)

3.22 Similarly, the majority of companies that invested in new technologies or processes to improve energy and/or resource efficiency have a business plan, double that of companies that have not invested (65% compared to 30%, see Table 3-12). A little less than half (44%) of those who have not invested in new technologies or processes to improve energy and/or resource efficiency do not have a business plan.

Table 3-12: Which of the following best describes your company's business plan? – by innovation activity

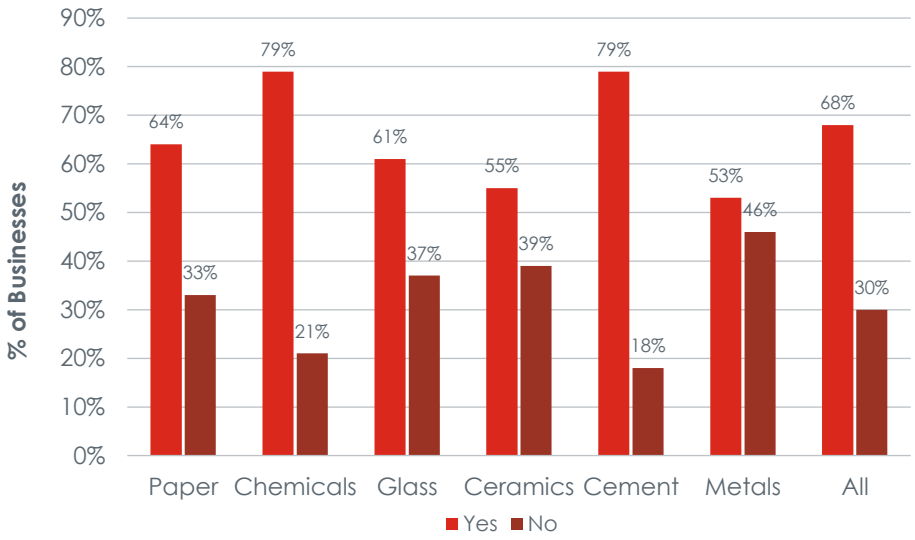
	Had invested in new technologies or processes to improve energy and/or resource efficiency (n=160)	Had not invested in new technologies or processes to improve energy and/or resource efficiency (n=236)
My company has a business plan, and it was updated in the financial year April 2019-March 2020	65%	30%
My company has a business plan, but it was not updated in the financial year April 2019-March 2020	19%	24%
My company does not have a business plan	15%	44%
Don't know	1%	1%
Refused	0%	1%

Source: SQW analysis of business survey
Base: All survey participants that responded 'yes' or 'no to investment in new technologies or processes to improve energy and/or resource efficiency (n=396)

3.23 However, there was a relationship between not having a business plan and business size: of the 129 businesses that said they did not have a business plan (n=400), 80% were micro-businesses, 19% were small businesses, and only 2% were medium businesses. No large businesses reported not having a business plan.

3.24 Encouragingly, around two thirds (68%) of companies with a business plan have actions relating to R&D and/or innovation (Figure 3-15). This is highest in the cement and chemicals sectors (both 79%) and lowest among metals (53%).

Figure 3-15: Does your business plan include actions to be taken relating to R&D and innovation? By sector

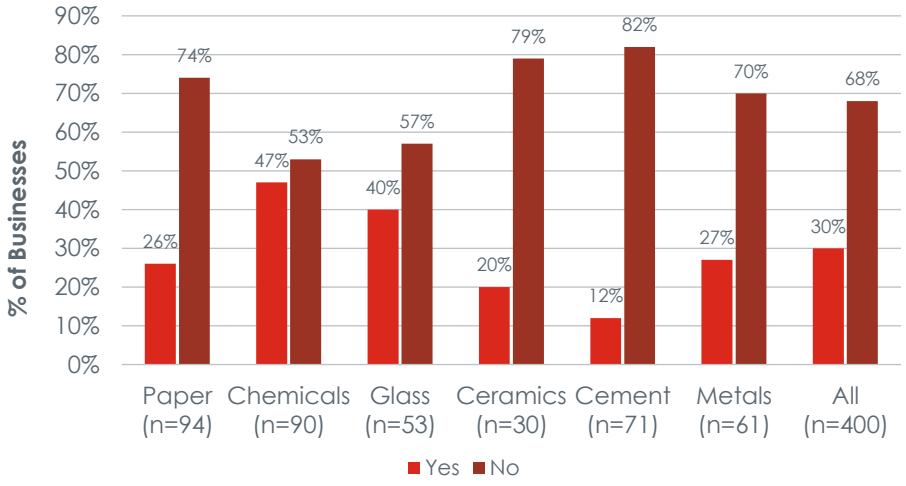


Source: SQW analysis of business survey
Base: All businesses that have a business plan (n=264)

Collaboration

3.25 Figure 3-16 illustrates that around one-third of businesses collaborated with other organisations to develop new products, services or processes but the majority did not (30% collaborating versus 68% not). The gap between those collaborating and those that did not was most profound in cement, ceramics, paper and metals. The gap is closer in chemicals and glass.

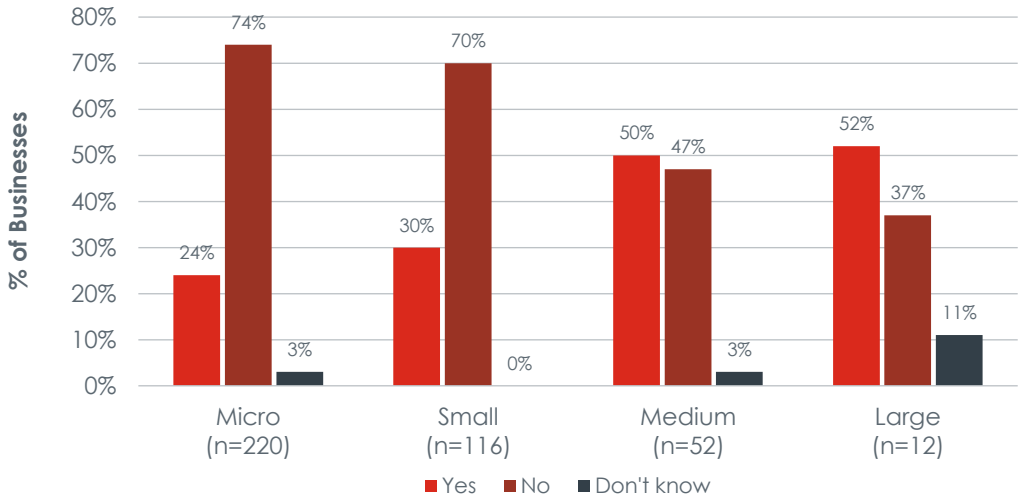
Figure 3-16: In the financial year April 2019 to March 2020, did your businesses collaborate with other organisations to develop new products, services or processes? By Sector



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.26 Collaboration increases by size of business, especially for medium and large businesses (Figure 3-17).

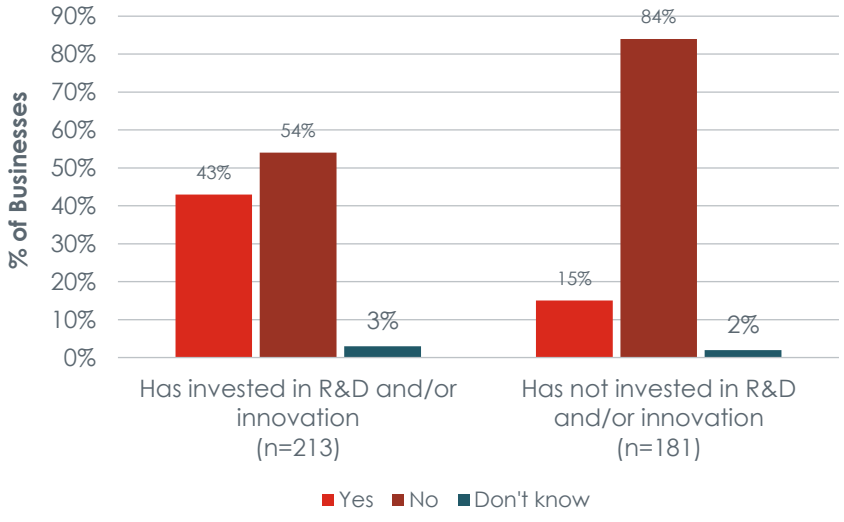
Figure 3-17: In the financial year April 2019 to March 2020, did your business collaborate with other organisations to develop new products, services or processes? By size of business



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.27 Perhaps unsurprisingly, those companies that have invested in R&D and/or innovation were more likely to have collaborated with other organisations (43%) than companies that had not invested in R&D and/or innovation (15%) (Figure 3-18).

Figure 3-18: In the financial year April 2019 to March 2020, did your businesses collaborate with other organisations to develop new products, services or processes? By innovation activity



Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.28 Collaboration was most common with other businesses, although there was no difference overall between collaboration with businesses in the same or a different sector (62% each). There were much lower levels of collaboration with universities (23%) and other research institutes (11%) (Table 3-13).

Table 3-13: Which of the following types of organisations did you collaborate with?

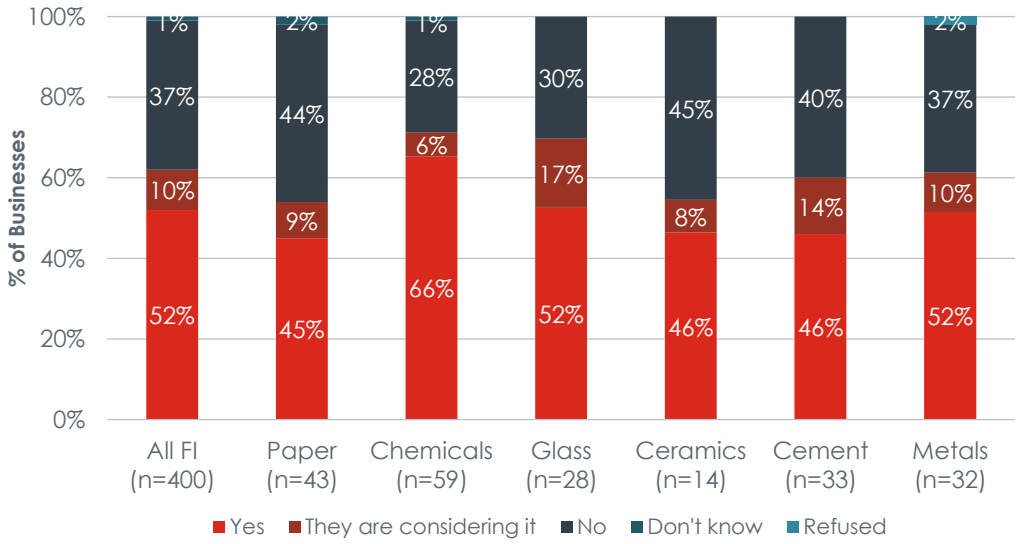
	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All
Other businesses – from your sector	59%	60%	50%	64%	95%	75%	**62%**
Other businesses – from a different sector	52%	69%	79%	52%	38%	49%	**62%**
Universities or other higher education institutions	17%	25%	22%	25%	22%	30%	**23%**
Government or public research institutes	6%	12%	22%	5%	5%	11%	**11%**
Private sector finance providers	6%	4%	0%	22%	11%	8%	**6%**
Other	6%	3%	0%	8%	-	0%	**3%**
N	**25**	**42**	**21**	**6**	**8**	**16**	**119**

Source: SQW analysis of business survey
Base: All businesses that had collaborated with other organisations (n=119)

Net Zero

3.29 Around half of businesses reported that their senior management had taken action to improve both energy and resource efficiency (Figure 2-5). This was highest in chemicals, glass and metals, followed by cement, ceramics and paper.

Figure 3-19: Did senior management within your business take action to improve energy and/or resource efficiency? By sector



Source: SQW analysis of business survey
Base: All survey participants (n=400)
Note, totals may not sum correctly due to rounding errors.

3.30 Across all FI, the most commonly cited reasons behind actions to improve energy and/or resource efficiency were to cut costs, and business commitment to the net zero agenda (Table 3-14). This was reasonably consistent across the six sectors. Other less cited reasons related to competitive advantage, government's net zero target, improve/maximise efficiency, and customer pressure.

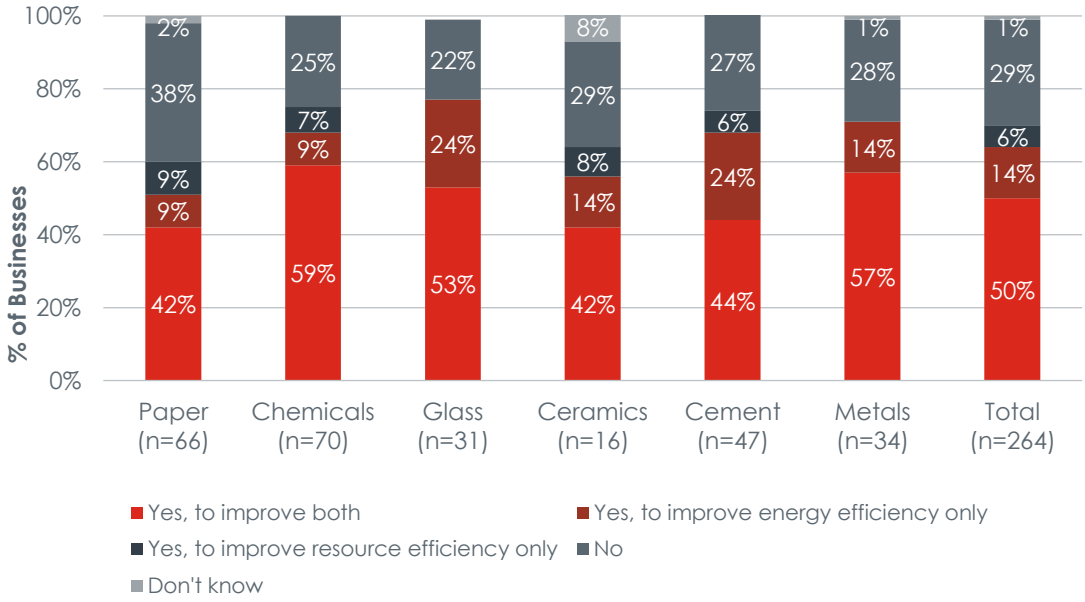
Table 3-14: What was the main reason behind this action to improve energy and/or resource efficiency?

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
Cutting costs	34%	44%	41%	44%	30%	59%	**42%**
Business commitment to net-zero agenda	42%	29%	40%	46%	40%	18%	**34%**
Competitive advantage (spontaneous)	14%	5%	-	-	30%	1%	**9%**
Government's net zero target	7%	7%	6%	3%	-	6%	**5%**
Improve / maximise efficiency (spontaneous)	-	5%	2%	-	-	10%	**3%**
Customer pressure (spontaneous)	4%	3%	-	-	-	1%	**2%**
Other	-	5%	5%	3%	-	1%	**3%**
Don't know	-	1%	6%	3%	-	3%	**2%**
Total firms	**43**	**59**	**28**	**14**	**33**	**32**	**208***

Source: SQW analysis of business survey
Base: All survey participants that took action to improve energy and/or resource efficiency (n=208)
**Note, totals may not sum correctly due to rounding errors.*

3.31 Overall, half of businesses reported that their business plan included actions intended to improve both energy and resource efficiency in their company (Figure 3-20). This was highest amongst businesses in chemicals, metals and glass.

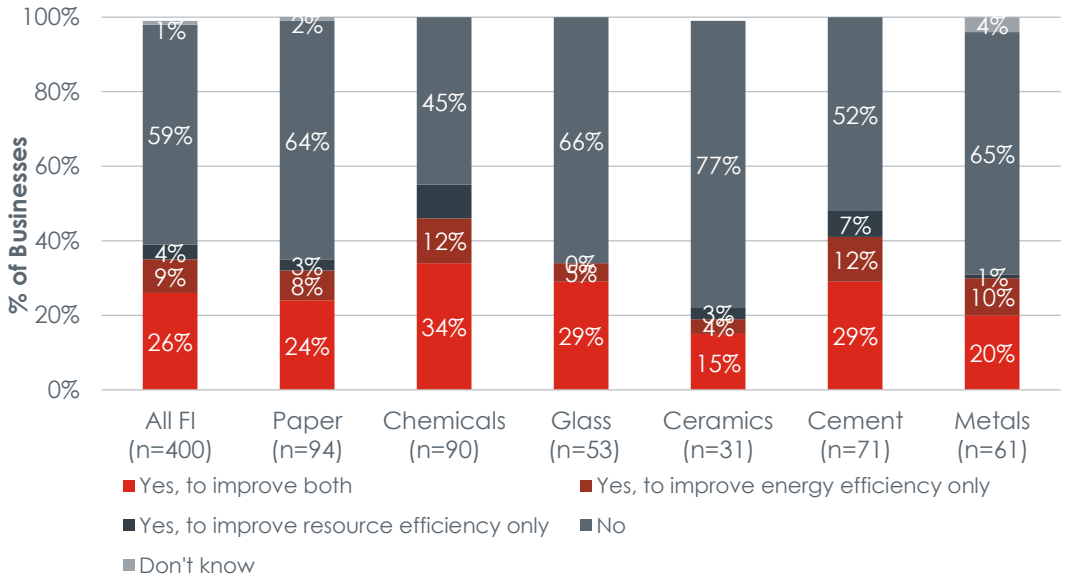
Figure 3-20: Did your company business plan include actions intended to improve energy and/or resource efficiency in your company?



Source: SQW analysis of business survey
Base: All survey participants that had a company business plan (n=264)

3.32 Just over a quarter (26%) of all firms had invested in new technologies or processes to improve both energy and resource efficiency (Figure 3-21). Of the firms that did not, approximately four in five had not invested in any new technologies or processes. The proportion of firms that had invested in new technologies or processes to improve both energy and resource efficiency was relatively higher in chemicals (34%) and lowest in ceramics (15%).

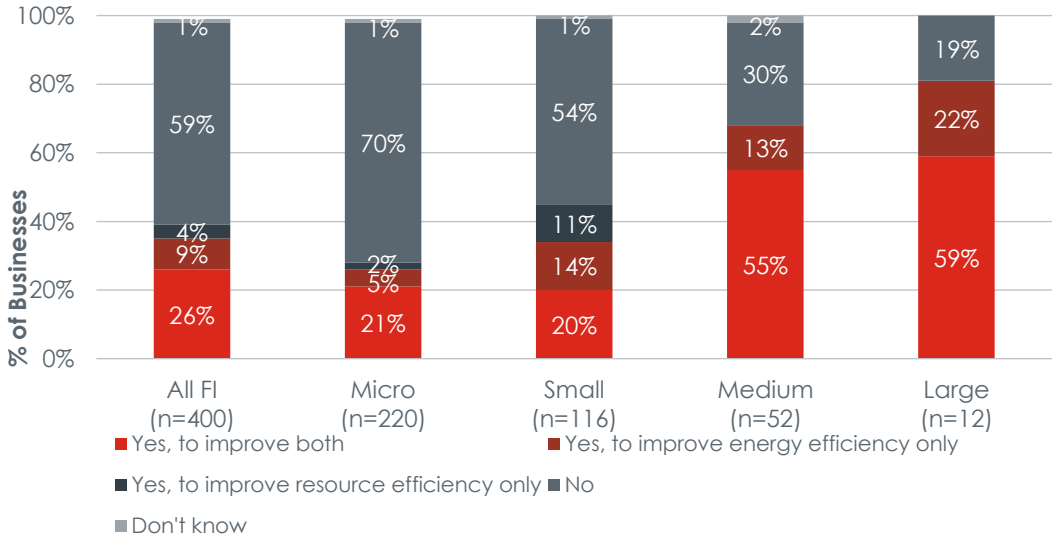
Figure 3-21: Had your company invested in new technologies or processes to improve energy and/or resource efficiency?



Source: SQW analysis of business survey
Base: All survey participants (n=400)
**Note, totals may not sum correctly due to rounding errors.*

3.33 A higher proportion of large and medium sized firms (55%) than micro and small firms had invested in new technologies or processes to improve both energy and resource efficiency (Figure 3-22).

Figure 3-22: Had your company invested in new technologies or processes to improve energy and/or resource efficiency? By size of business



Source: SQW analysis of business survey
Base: All survey participants (n=400)
**Note, totals may not sum correctly due to rounding errors.*

3.34 Businesses which had previously invested in R&D and/or innovation had also invested in new technologies or processes to improve both energy and resource efficiency (Table 3-15).

Table 3-15: Had your company invested in new technologies or processes to improve energy and/or resource efficiency? By innovation activity (n=394)

	Investment in R&D and/or innovation in FY 2019/20	
	Yes	No
Yes, to improve both	39%	11%
Yes, to improve energy efficiency only	10%	8%
Yes, to improve resource efficiency only	5%	3%
No	44%	76%
Don't know	1%	1%
Total firms	**213**	**181**

Source: SQW analysis of business survey
Base: All survey participants excluding respondents stating 'Don't know' (n=394)

3.35 Table 3-16 provides a breakdown of responses to a number of statements relating to business' senior management team and the net zero agenda. In summary:

- Across all FI, the majority of businesses agreed with the statements that their senior management team recognise the importance of the Government's net zero agenda and recognise the importance of innovation within their firm to working towards Net Zero.
- A third of all firms neither agreed nor disagreed that their senior management team had accelerated the pace of reducing carbon emissions in response to the national Net Zero target. The proportion of firms which agreed with this statement was relatively higher in cement (51%) and chemicals (45%), but much lower in metals (30%).
- Overall, a higher proportion of all firms agreed that their senior management team have the necessary skills to deliver innovation related to Net Zero successfully.[10]

Table 3-16: The senior management team within my business ...? By sector

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
Total firms	94	90	53	30	71	61	400
Recognise the importance of the Government's Net Zero agenda							
Strongly disagree	9%	3%	3%	1%	-	6%	4%
Disagree	12%	4%	6%	3%	4%	6%	6%
Neither agree nor disagree	16%	22%	19%	10%	21%	26%	20%
Agree	26%	37%	35%	44%	46%	37%	36%
Strongly agree	32%	34%	38%	41%	29%	24%	32%
Don't know	5%	-	-	-	-	2%	1%
Recognise the importance of innovation within your firm to working towards Net Zero							
Strongly disagree	9%	2%	1%	4%	-	7%	4%
Disagree	8%	7%	3%	6%	7%	7%	7%
Neither agree nor disagree	23%	13%	21%	20%	16%	16%	18%
Agree	37%	49%	49%	41%	59%	51%	48%
Strongly agree	21%	28%	26%	29%	18%	16%	23%
Don't know	2%	1%	-	-	-	2%	1%
Accelerated the pace of reducing carbon emissions in response to the national Net Zero target							
Strongly disagree	12%	9%	10%	5%	4%	16%	10%
Disagree	22%	21%	17%	20%	4%	23%	18%
Neither agree nor disagree	32%	24%	33%	34%	28%	30%	30%
Agree	20%	31%	23%	17%	38%	27%	27%

[10] By contrast, the ERC (2021) report 'Innovation Readiness in UK Foundation Industries', identified institutional barriers to low carbon innovation including a lack of skilled staff and capabilities.

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
Total firms	94	90	53	30	71	61	400
Strongly agree	11%	14%	16%	22%	13%	3%	12%
Don't know	2%	2%	-	-	7%	2%	2%
Refused	-	-	1%	2%	7%	-	1%
Have the necessary skills to deliver innovation related to Net Zero successfully							
Strongly disagree	9%	6%	3%	7%	0%	6%	5%
Disagree	24%	18%	20%	23%	23%	32%	23%
Neither agree nor disagree	31%	22%	37%	18%	23%	26%	27%
Agree	28%	39%	26%	37%	27%	27%	31%
Strongly agree	6%	11%	14%	12%	14%	7%	10%
Don't know	2%	2%	-	2%	7%	2%	2%
Refused	-	2%	-	-	7%	-	2%

Source: SQW analysis of business survey
Base: All survey participants (n=400)

3.36 Table 3-17 shows that across all business sizes, the majority of firms agreed or strongly agreed that their senior management team both recognise the importance of the Government's Net Zero agenda and recognise the importance of innovation within their firm to working towards Net Zero. Similar to the sector analysis (with the exception of micro firms), the majority of firms neither agreed nor disagreed that their senior management team had accelerated the pace of reducing carbon emissions in response to the national Net Zero target.

Table 3-17: The senior management team within my business ...? By business size

	Micro	Small	Medium	Large
Total firms	220	116	52	12
Recognise the importance of the Government's Net Zero agenda				
Strongly disagree	3%	5%	8%	0%
Disagree	4%	10%	6%	11%
Neither agree nor disagree	18%	25%	19%	7%
Agree	40%	26%	47%	18%
Strongly agree	34%	32%	17%	63%
Don't know	1%	1%	3%	-
Refused	3%	5%	8%	-
Recognise the importance of innovation within your firm to working towards Net Zero				
Strongly disagree	4%	6%	1%	0%
Disagree	6%	10%	4%	7%
Neither agree nor disagree	17%	18%	21%	26%

	Micro	Small	Medium	Large
Total firms	220	116	52	12
Agree	46%	44%	63%	37%
Strongly agree	26%	21%	11%	30%
Don't know	2%	-	-	-
Refused	4%	6%	1%	-
Accelerated the pace of reducing carbon emissions in response to the national Net Zero target				
Strongly disagree	8%	11%	16%	7%
Disagree	21%	14%	11%	37%
Neither agree nor disagree	24%	40%	31%	19%
Agree	30%	26%	22%	11%
Strongly agree	12%	9%	17%	26%
Don't know	3%	-	3%	-
Refused	2%	1%	-	-
Have the necessary skills to deliver innovation related to Net Zero successfully				
Strongly disagree	6%	6%	5%	-
Disagree	24%	20%	21%	44%
Neither agree nor disagree	26%	28%	31%	11%
Agree	30%	34%	27%	26%
Strongly agree	9%	12%	10%	18%
Don't know	3%	1%	3%	-
Refused	6%	6%	5%	-

Source: SQW analysis of business survey
Base: All survey participants (n=400)

Skills

3.37 A high majority of firms (88%) reported that between 76% and 100% of their staff were fully proficient at their job (Table 3-18). This was fairly consistent across all sectors.

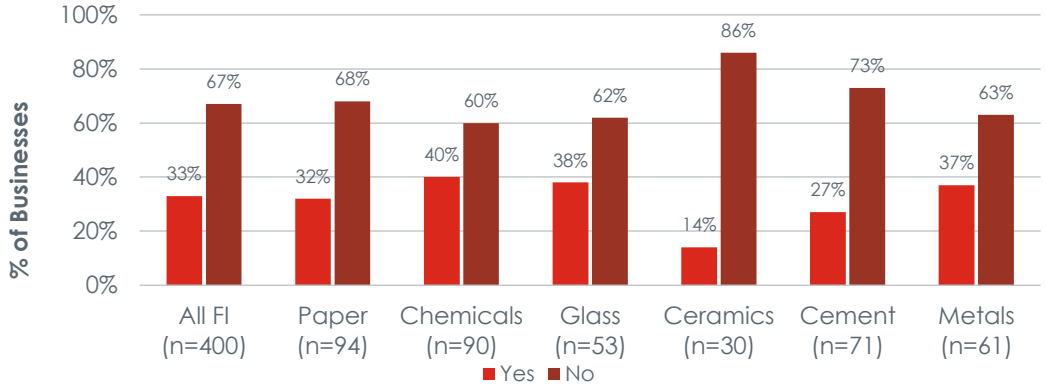
Table 3-18: What percentage of your staff would you regard as fully proficient at their job?

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
< 25%	2%	1%	1%	-	-	2%	**1%**
26% - 50%	5%	1%	3%	-	-	2%	**2%**
51% - 75%	5%	10%	8%	5%	16%	9%	**9%**
76% - 100%	89%	88%	88%	95%	84%	88%	**88%**
Total firms	**94**	**90**	**53**	**30**	**71**	**61**	**400**

Source: SQW analysis of business survey
*Base: All survey participants (n=400) *Note, totals may not sum correctly due to rounding errors.*

3.38 Approximately two thirds of all firms did not have any vacancies that were proving hard to fill because applicants did not have the right skills (Figure 3-23). Chemicals and metals had the highest proportion of firms which reported they had previously had vacancies that were proving hard to fill due to applicants not having the right skills.

Figure 3-23: Did your company have any vacancies that are proving hard to fill because applicants did not have the right skills?



Source: SQW analysis of business survey
Base: All survey participants (n=400)
**Note, totals may not sum correctly due to rounding errors.*

3.39 Most respondents (87%) stated that they were struggling to find technical skills in job applicants or existing staff (Table 3-19). The next most needed were professional and innovation skills. This trend was broadly consistent across sectors. However, this seems somewhat contradictory in relation to the finding that most respondents indicated they did not have any vacancies that were proving hard to fill because applicants did not have the right skills.

Table 3-19: What kind of skills are you struggling to find in job applicants or existing staff? By sector

	Paper	Chemicals	Glass	Ceramics	Cement	Metals	All FI
Technical skills	90%	88%	93%	89%	65%	94%	**87%**
Professional skills	42%	39%	47%	59%	56%	38%	**44%**
Innovation skills	67%	36%	48%	11%	14%	26%	**39%**
Management and leadership skills	34%	23%	33%	17%	34%	16%	**27%**
Digital skills	28%	32%	18%	42%	2%	16%	**22%**
Other	5%	5%	4%	6%	14%	2%	**5%**
Total firms	**30**	**36**	**20**	**4**	**19**	**23**	**133**

Source: SQW analysis of business survey
Base: All survey participants reporting hard to fill vacancies (n=133)

3.40 The type of skills firms reported that they were struggling to find varied according to the size of the company (Table 3-20). For example, a greater proportion of medium and large firms than micro and small firms struggled to find innovation, management and leadership skills.

Table 3-20: What kind of skills are you struggling to find in job applicants or existing staff? By size of business

	Micro	Small	Medium	Large	All FI
Technical skills	96%	84%	85%	72%	**87%**
Professional skills	42%	58%	25%	32%	**44%**
Innovation skills	25%	37%	53%	64%	**39%**
Management and leadership skills	22%	19%	44%	44%	**27%**
Digital skills	18%	22%	23%	36%	**22%**
Other	4%	10%	-	0%	**5%**
Total firms	**39**	**54**	**28**	**11**	**133**

Source: SQW analysis of business survey
Base: All survey participants reporting hard to fill vacancies (n=133)

4. Secondary data analysis

4.1 This section contains analysis of secondary data relating to the foundation industries (FI) as part of the baseline for the evaluation of the Transforming Foundation Industries Industrial Strategy Challenge Fund (TFI ISCF). The metrics were agreed with the TFI Challenge team as part of the development of the evaluation framework. The full list of outcome and impact metrics is given at Annex D. The analysis was undertaken by Cambridge Econometrics (CE).

4.2 The purpose of this analysis is to provide sector-level evidence about the circumstances in which the TFI programme operates, both in terms of the original position when the Challenge was announced, and to contextualise performance during the evaluation. It is worth bearing in mind that:

- Baseline data are provided up to end of the financial year 2019/20, which is the point at which the TFI programme was launched publicly. **The data therefore provide information on the state of the foundation industries prior to the TFI Challenge**. They do not provide any information on the performance of the TFI ISCF to date.
- The process and impact evaluation phases in 2022 and 2023/24 will re-visit the same metrics to understand how the performance of the foundation industries has changed during the lifespan of the TFI Challenge.
- The data provide **context** for understanding findings from other sources of evidence, including the business survey and cannot explain any direct causal links in changes of performance.
- The data describe the FI as a whole industry and at the sector level. As such, it cannot provide a detailed look at the different types of businesses within the sectors nor indeed of businesses within the supply chains and wider economy that also interact with the FI. Other aspects of the evaluation will be able to explore these nuances.

Methodology

4.3 This historical baseline for the foundation industries is shown as the five years leading up to the launch of the TFI programme (2014 to 2019). The baseline comprises secondary data gathered from a range of publicly available data sources and estimates, using the most up-to-date data available for each indicator. In some cases, the latest year of data available is 2018. In such cases, the historical data has been extended to 2019 using the databank from CE's in-house economic model, MDM. MDM is developed and maintained by CE as a framework for generating detailed economic forecasts and analysing changes in economic structure.

4.4 The analysis compares trends across the six foundation industries sectors listed above[11], the FI in aggregate, the entire manufacturing sector (the FI and the rest of the manufacturing sector, as defined by SIC Section C) and the wider (non-financial) economy (i.e. the overall economy, excluding financial and insurance activities as defined by SIC Section K[12]). While there are clearly important differences between the foundation industries and the wider manufacturing sector, comparison provides a useful point of reference for assessing the performance of the foundation industries. Any divergences can be explored to understand reasons for improving or declining performance by the FI and its sectors.

4.5 The analysis covers the following baseline indicators:

- Output (turnover)
- Gross value added (output having accounted for inputs)
- Gross operating profit (as a measure of profitability)
- Employment
- Labour productivity
- Exports and imports
- Investment
- R&D spending
- Foreign direct investment (FDI)
- Energy intensity
- Emissions intensity[13].

4.6 For R&D spending, FDI and energy intensity, the granularity of available data means that the indicators are presented for slightly wider industry definitions than those given above. More detail is provided alongside the relevant indicators. The use of slightly wider industry definitions for these metrics may affect the indicators but it is hard to determine how and to what extent. As the industry definitions are only slightly wider it is probably that the indicators are reasonably reflective of what is going on in the FI sectors. At the very least, the indicators are likely to provide a good indication of the overarching trend for these metrics if not the levels.

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[11] These sectors are based on UKRI's working definition of the foundation industries, using 2007 SIC codes, as per the Evaluation Framework (March 2021). The definition is provided in Annex A.
[12] SIC Section K is not covered by the Annual Business Survey (ABS) and so has been excluded from comparison for indicators drawn from the ABS.
[13] While the challenges relating to the use of the terms energy intensity and emissions intensity are recognised, we have retained the use of 'intensity' to be consistent with the terminology used by ONS and other data sources.

International comparisons

4.7 The baseline provides a comparison between the UK's foundation industries with those in Germany, France and Belgium in 2018 (the most recent year for which comparable data are available) for key indicators. The comparator countries were chosen based on the following criteria:

- UK domestic market penetration – a key objective of the TFI programme outlined in the business case is the displacement of imports into the UK domestic market.
- Importance of the UK market to the foreign exporter – countries that export a high proportion of their total exports to the UK are more likely to produce goods that are customised to the UK market (as opposed to countries exporting lower value-added goods across the world). These are the types of goods that UK producers are likely competing to sell on the domestic market.[14]
- Data availability – to facilitate meaningful comparison between countries, data should be comparable and consistent in terms of sector definitions and indicator definitions, and the methodology for collecting and collating the data.

Economic and emissions projections

4.8 Projections are provided for the six foundation industry sectors out to 2040 for gross value added (GVA), employment, labour productivity and emissions. These projections are derived from CE's forecasting model, MDM, and analysis of historical trends.

4.9 MDM provides a one-model approach in which the detailed industry analysis is consistent with the macroeconomic analysis. In addition to the statistical mechanisms within MDM, the model also methodically adjusts based on internal assumptions about the likely future. This is done by routinely assembling a team of economists to assess the latest available literature and evidence to revise the forecast's short-run outlook. It allows the model to account for major events such as Brexit or the COVID-19 outbreak, which are not well captured by the analysis of long-run historical trends.

4.10 The projections in this paper are based on the latest edition of MDM from March 2021. It assumes that lockdown and social distancing measures will follow the Government's envisaged 'road map', with lockdown formally ending in late March, social distancing to progressively ease over spring and the domestic economy to open fully by mid/late summer. Despite the assumed opening of the UK economy in the second half of 2021, persistent economic scarring and a muted economic recovery in 2021/2022 is expected. Further detail on the model assumptions around Covid-19 impacts is given in Annex F:.

[14] Note that the goods being measured are those being exported by FI sectors so they will be products sold rather than raw materials processed by FI. Depending on the sector/product, it could be a mix of intermediate (semi-processed) goods and finished goods.

4.11 Assumptions around Brexit trade disruptions are based on expected impacts of the EU–UK Trade and Cooperation Agreement, which was signed on 30th December 2020. Based on this Agreement, the following assumptions are incorporated into MDM:

- The agreed Free Trade Agreement with the EU avoids reversal to WTO terms but results in some barriers to trade which will gradually phase in.
- The points-based migration system introduces restrictions on inward migration from the EU.
- While the possibility of no-deal Brexit is lifted, some uncertainty remains over the speed of regulatory divergence.
- Some uncertainty remains over the possibility of changes to the agreement in the future that could affect the barriers to trade, such as the equivalence rules in the financial sector.
- The UK will continue to seek other trade agreements, which could reduce barriers to trade with non-EU countries in the future.

4.12 To develop the projections for GVA and employment, the latest MDM sector forecasts (SIC 2-digit) for GVA and employment have been applied to the latest year of historical baseline data for each of the foundation industry sectors. The labour productivity projection is then calculated from the GVA and employment projections.

4.13 The emissions projections are calculated based on estimating emission intensity factors and applying them to the GVA projections. Emissions intensity factors are projected forward based on the time trend in the historical data. In some cases, time trends in emissions factors are very weak and, consequently, we cannot reliably assert that the factors are increasing or decreasing over time. For these cases, we therefore take the latest year (2019) of observed emissions factors and apply this to projected years of GVA.

Historical performance of the Foundation Industries, 2014-19

4.14 It is worth noting that over the relatively short time period of five years, there is some volatility evident among some sectors on some metrics. Average rates may be influenced by a particularly high or low performance on a specific metric for the starting year, 2014, and/or the final year, 2019. Where possible, we have explored reasons for volatility. However, the findings should still be treated with caution.

The wider economic context

4.15 Both the wider economic landscape and trends in the manufacturing sector in the UK need to be taken into account when considering the performance of the UK foundation industries in recent years.

4.16 The years following the recession of 2008 to 2009 were characterised by accelerating GDP growth in the UK, which peaked at 2.9% in 2014. GDP growth slowed but remained strong in

2015 at 2.4%, and continued to slow down thereafter, reaching 1.4% in 2019, driven in part by the uncertainty brought about by the 2016 Brexit referendum and subsequent negotiations, lacklustre domestic demand and increasing global trade tensions.

4.17 Longer-term, whilst remaining a significant and important part of the UK economy, the manufacturing sector as a whole has seen significant declines in output and employment, driven by lower-cost competition from overseas and the fragmentation of global supply chains. In 1990, manufacturing accounted for around 20% of output in the whole economy and 17% of all employment. By 2018 this had fallen to 10% of output in the whole economy and 8% of total employment.

Diversity within UK foundation industries

4.18 Before presenting performance of the FI on key metrics, it is worth nothing that economic activity within most of the foundation industry sectors is dominated by one or two large sectors (as shown in Table 4-1). In ceramics, cement and metals, the largest sector represented more than 60% of GVA in 2018, while in the paper and pulp sector, the largest sector represented 42% of GVA. In the glass sector, two sectors (out of four) represented 76% of GVA. Chemicals is the most diversified sector, with the manufacture of other chemical products accounting for 26% of GVA in 2018, and the rest of the sector's GVA being shared relatively evenly among five other sectors. Therefore, the GVA figures shown in the following tables largely depend on the performance of the most significant sectors within each foundation industry, with turnover and Gross Operating Surplus[15] (GOS) (a proxy for profitability) broadly following a similar pattern.

Table 4-1: Share of most significant subsectors in terms of GVA, 2018

Sector	Subsector	Share
Paper and pulp	17.21 Manufacture of corrugated paper and paperboard and containers of paper and paperboard	42%
Chemicals	20.59 Manufacture of other chemical products n.e.c.	26%
Glass	23.12 Shaping and processing of flat glass	39%
	23.13 Manufacture of hollow glass	38%
Ceramics	23.32 Manufacture of bricks, tiles and construction products, in baked clay	60%
Cement	23.63 Manufacture of ready-mixed concrete	74%
Metals	24.1 Manufacture of basic iron and steel and of ferro-alloys	73%

Source: ONS (Annual Business Survey)

[15] Gross Value Added minus employment costs.

Key performance metrics

Output and profitability

Turnover, GVA and gross operating surplus

4.19 The recent performance of the foundation industries in the UK can be assessed using the data presented in Table 4-2. This presents data on recent trends in output (as measured by real turnover and real gross value added (GVA)) and a broad measure of profitability (real gross operating surplus) in the UK foundation industries, manufacturing sector and wider non-financial economy for the period 2014-19.

4.20 Total foundation industries GVA increased[16] at an average annual rate of 1.2% over 2014-19, markedly slower than the wider non-financial economy (2.2% average annual growth rate), while the manufacturing sector GVA marginally declined over the same period at a rate of -0.2% per annum. Of the individual foundation industry sectors, cement displayed the strongest growth between 2014 and 2019, with growth of 24.5% per annum on average, followed by ceramics (8.1% per annum) and glass (5.7% per annum).

4.21 The strong growth in the cement sector between 2014 and 2019 was driven by a particularly large increase over 2014-15 in the manufacture of ready-mixed concrete sector. Thereafter, GVA in the cement sector barely changed over 2015-19. The large and sustained jump in cement sector GVA coincided with the completion in 2015 of the merger between Holcim and Lafarge to create the world's biggest cement manufacturer, directly affecting the UK market through the incorporation of Holcim's Aggregate Industries into the merged entity[17]. As such, it is likely that the increased GVA in the sector was driven by changes to accounting or reporting of GVA data brought about by the merger, especially given a similar increase was not observed in output or employment.

4.22 The chemicals sector, the largest of the foundation industry sectors in terms of GVA, grew at an average annual rate of just under 3%, while the paper and pulp sector and the metals sector contracted by around 4% per annum and 7.5% per annum respectively. GVA in the metals sector declined significantly over 2015-16, amid steel plant closures and production cuts due to the pressure of international competition and rising production costs[18]. GVA in the metals sector recovered temporarily in 2017, before continuing its decline over the following two years.

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[16] Growth here is measured by average growth rate per annum from 2014-18. It is important to note that the growth within a period reflects the differences between the starting and the end point of a series, and therefore it is not per-se indicative of a trend, i.e. the series might oscillate significantly between the two points.
[17] https://globalcement.com/magazine/articles/985-the-uk-cement-industry-in-2015-2016
[18] https://commonslibrary.parliament.uk/research-briefings/cbp-7317/

4.23 The picture is similar in terms of turnover: the foundation industries grew at nearly half the rate of the wider non-financial economy over 2014-19 (1.1% compared to 1.9% average annual growth), but faster than the manufacturing sector (which declined by 0.1% per annum due to a sharp drop in 2019). Of the foundation industry sectors, cement and ceramics turnover increased most strongly (as with GVA), growing at 11.7% and 4% respectively per annum. Chemicals turnover grew at a 3% average annual rate, similar to chemicals GVA growth. Meanwhile, paper and pulp, glass, and metals turnover stayed flat or contracted slightly over the period (this was the same direction of travel for paper and pulp and metals as for their GVA but glass grew when measured in GVA). The contrasting trends in turnover and GVA across the individual foundation sectors highlights their heterogeneity.

4.24 Gross Operating Surplus (GOS), an indicator of profitability, increased at an average annual rate of 2% across the foundation industries as a whole over 2014-19 sustained by the increase in GVA, and broadly in line with the wider non-financial economy. GOS grew particularly sharply over 2014-15 in the cement sector (752% per annum) driven by a sharp increase in profitability in the ready-mixed concrete sector, which was broadly sustained to 2019. As with GVA this may reflect changes to accounting or reporting of the data as a result of the completion in 2015 of the global merger between Holcim and Lafarge rather than an increase in profitability in the UK sector. GOS also grew quickly on average in the ceramics sector (14.9% per annum), and the glass sector (27.7% per annum), and less so in chemicals (4.1% per annum), while it declined in the metals sector and the paper and pulp sector (-23.6% and -6.8% per annum respectively). As with GVA, the sharp decline in metals GOS is likely linked both to the 2015/16 steel crisis but also to the longer-term pressures from international competition that the sector faces.

Table 4-2: Recent trends in output and profitability in the foundation industries, manufacturing sector, and wider (non-financial) economy, 2014-19

		2014	2015	2016	2017	2018	2019	Average growth
GVA (£ 2018 millions)	Paper and pulp	4,071	4,087	3,419	3,279	3,372	3,367	-3.7%
	Chemicals	4,992	4,413	4,633	5,309	5,806	5,765	2.9%
	Glass	825	1,029	1,148	1,231	1,137	1,089	5.7%
	Ceramics	660	890	919	1,013	1,042	974	8.1%
	Cement	390	1,378	1,365	1,162	1,246	1,165	24.5%
	Metals	2,041	1,971	1,352	1,821	1,467	1,385	-7.5%
	Foundation Industries	12,979	13,766	12,836	13,816	14,070	13,744	1.2%
	Manufacturing	168,169	167,150	165,403	171,611	169,759	166,224	-0.2%
	Non-financial economy	1,161,249	1,210,220	1,212,511	1,244,681	1,273,502	1,292,000	2.2%
Turnover (£ 2018 millions)	Paper and pulp	11,929	12,274	12,067	12,329	12,187	11,865	-0.1%
	Chemicals	16,578	17,541	19,424	19,554	19,505	19,210	3.0%
	Glass	3,367	3,414	3,311	3,469	3,352	3,219	-0.9%
	Ceramics	1,592	1,900	1,820	1,969	2,058	1,936	4.0%
	Cement	2,330	4,803	4,465	4,269	4,317	4,060	11.7%
	Metals	12,005	11,222	10,814	10,839	10,731	10,267	-3.1%
	Foundation Industries	47,801	51,154	51,901	52,428	52,150	50,556	1.1%
	Manufacturing	557,062	556,832	565,415	566,768	570,095	555,024	-0.1%

		2014	2015	2016	2017	2018	2019	Average growth
	Non-financial economy	3,711,926	3,601,536	3,722,437	3,931,722	4,007,140	4,067,503	1.9%
Gross operating surplus (£ 2018 millions)	Paper and pulp	2,092	2,109	1,489	1,304	1,422	1,469	-6.8%
	Chemicals	2,879	2,059	2,001	3,031	3,530	3,524	4.1%
	Glass	143	351	484	534	510	487	27.7%
	Ceramics	253	396	441	515	545	506	14.9%
	Cement	89	901	857	665	762	709	51.6%
	Metals	789	646	-681	517	234	205	-23.6%
	Foundation Industries	6,244	6,463	4,591	6,567	7,003	6,900	2.0%
	Manufacturing	81,837	76,858	70,736	79,626	77,823	76,718	-1.3%
	Non-financial economy	559,503	583,644	571,060	590,447	608,886	621,851	2.1%

Note: data for 2019 is estimated using MDM. Totals may not sum accurately due to rounding.
Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Employment

4.25 Table 4-3 shows baseline employment data for the foundation industries, the manufacturing sector and the wider non-financial economy for the period 2014-19. Total foundation industries sector employment grew at an average annual rate of 1.6% over 2014-19, driven by strong growth over 2016-18 after a small dip over 2014-16. Overall, 15,000 more workers were employed in 2019 than in 2014. **Employment growth in the foundation industries sector was below that for the wider non-financial economy (2.1% per annum), but well ahead of manufacturing, where employment grew at a rate of 0.3% per annum (matching trends in GVA and turnover for these three parts of the economy).** The faster employment growth in the foundation industries meant their share of employment in the wider manufacturing sector increased by ¼ to ½ percentage points[19] over the period.

4.26 The largest increase in employment, at around 5000 workers, was observed in the metals sector, driven by a sharp uptick in employment over 2016-18. The strongest average annual growth in employment was observed in ceramics at 4% (corresponding to around 3,000 workers). Employment also grew in chemicals and paper and pulp, with a marked increase over 2017-18 (+3,000 and 7,000 workers respectively), and in glass (+2,000 workers). In the cement sector, employment fell by 3,000 workers over 2014-15, before returning back gradually to 2014 levels in 2019. Note that **trends in employment for the individual sectors does not necessarily match their individual trends in GVA and turnover**. For example cement increased turnover and GVA but hardly changed in terms of employment.

Table 4-3 Employment (000s), 2014-19

	2014	2015	2016	2017	2018	2019	Average growth
Paper and pulp	57	56	56	55	62	60	0.9%
Chemicals	46	46	46	45	48	49	1.2%
Glass	20	18	19	22	21	22	1.5%
Ceramics	14	14	14	16	17	17	4.0%
Cement	18	15	15	17	17	18	0.1%
Metals	31	30	30	33	36	36	2.8%
Foundation Industries	186	180	181	189	201	201	1.6%
Manufacturing	2,490	2,497	2,521	2,569	2,576	2,532	0.3%
Non-financial economy	22,534	23,377	24,043	24,299	24,610	25,013	2.1%

Note: data for 2019 is estimated using MDM. Totals may not sum accurately due to rounding
Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

[19] A percentage point is the unit for the arithmetic difference of two percentages e.g. moving up from 50% to 55% is a 5 p.p. increase.

Labour productivity

4.27 Table 4-4 shows labour productivity measured as real GVA per worker. Labour productivity growth was flat over 2014-19 for the wider non-financial economy while in the foundation industries it declined at an average annual rate of 0.4%, broadly in line with manufacturing (-0.6% per annum). The foundation industries as a whole had a higher level of productivity on average compared to the both the wider non-financial economy and the manufacturing sector. However, there was significant variation in productivity across the foundation industry sectors, with chemicals the most productive sector by a large margin. At the same time, labour productivity in several of the individual foundation industries sectors was lower than the average for manufacturing as a whole.[20]

4.28 Within the foundation industries, labour productivity (as measured by GVA per worker) increased in chemicals (+1.7% average annual growth), glass (+4.1%), ceramics (+4%) and cement (+24.4%, driven by a sharp increase over 2014-15), while it declined in paper and pulp (-4.6%) and metals (-10%). Some of these changes are likely to have been influenced by factors other than just worker behaviour/efficiency, for example changes in prices of raw materials.

Table 4-4: Labour productivity (£ 2018 thousands of GVA per worker), 2014-2019

	2014	2015	2016	2017	2018	2019	Average % growth
Paper and pulp	71	73	61	60	54	56	-4.6%
Chemicals	109	96	101	118	120	118	1.7%
Glass	41	57	60	56	54	50	4.1%
Ceramics	46	62	64	62	62	56	4.0%
Cement	22	89	89	68	73	66	24.4%
Metals	65	66	45	55	41	39	-10.0%
Foundation Industries	69	77	71	73	70	68	-0.4%
Manufacturing	68	67	66	67	66	66	-0.6%
Non-financial economy	52	52	50	51	52	52	0.1%

Note: data for 2019 is estimated using MDM.
Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

[20] As a measure that can usually be obtained/derived quite readily, labour productivity is a common and well established measure of productive efficiency and competitiveness. Labour productivity comparisons between countries are useful to compare the amount of value added per worker between sectors, across time, between countries etc.

4.29 R&D

4.30 Table 4-5 shows foundation industries R&D spending[21] in monetary terms (£m) and as a percentage of GVA.

Table 4-5: R&D expenditure, 2014-19

		2014	2015	2016	2017	2018	2019	Growth (pp or %)
R&D expenditure (£millions)	Paper and pulp	12	12	12	18	23	31	20.9%
	Chemicals	366	324	478	317	388	363	-0.2%
	Glass, Ceramics and Cement	49	42	51	72	88	83	11.1%
	Metals	71	61	78	99	91	80	2.4%
R&D expenditure / GVA (%)	Paper and pulp	0.3	0.3	0.4	0.5	0.7	-	0.4
	Chemicals	4.3	3.8	5.4	3.3	3.7	-	-0.5
	Glass, Ceramics and Cement	1.0	0.8	0.9	1.2	1.4	-	0.4
	Metals	1.6	1.4	2.0	2.5	2.4	-	0.8

Note: Data presented at a more aggregated SIC level of granularity than UKRI foundation industry sector definitions due to data limitations. SIC correspondence: Paper and pulp - SIC 17; Chemicals - SIC 20; Glass ceramic and cement - SIC23, Metals - SIC 24.
Source: ONS Research and Development in UK Businesses, 2019 and ONS Annual Business Survey

4.31 Both in absolute terms and as a percentage of GVA, chemicals spent the most on R&D in all years, despite not showing a specific trend (with R&D spend ranging from 3.3% of GVA to 5.4% of GVA over the period). The other sectors all increased their R&D spend over 2014-19. For example, metals also experienced a noticeable increase in R&D expenditure, even as metals sector GVA declined. Similarly, paper and pulp experienced clear growth in investment in R&D over 2014-19, despite GVA declining. However, it remains the foundation industry sector which spends the least in R&D both in absolute terms and as a percentage of GVA. Glass, ceramics and cement saw a sizeable increase in absolute value of R&D expenditure, corresponding to a 0.4 pp increase as share of GVA and outpacing the GVA growth depicted in Table 4-2.

[21] R&D expenditure includes funding from a variety of public and private sources. See Annex E for more detail.

Investment

4.32 Table 4-6 shows real investment (gross fixed capital formation) in the foundation industries, manufacturing and the wider non-financial economy during the period 2014-19[22]. Total foundation industries investment grew at an average rate of 1.3% per annum over 2014-19. However, this masks **a largely declining trend in investment. Total foundation industries investment grew by 15% over 2014-15 but then declined gradually over 2015-18, before a modest increase in 2019 that still was still lower than the level of investment in 2015**. Investment in the wider non-financial economy followed a similar dynamic. Manufacturing investment saw a large jump in 2015, but it fell back in 2016 and was then largely unchanged over the period, averaging growth of 1.7% per annum. Metals sector investment grew at an average rate of 1.5% per annum over 2014-19, but the trend was marked by a rapid increase over 2014-17 and then a sharp fall, with investment in 2018 and 2019 nearly half the level seen in 2017. Increased investment and R&D in the metals sector, despite the contraction in GVA, turnover and GOS highlighted above, was driven by strength in the manufacture of basic iron and steel sector. The sector that saw the strongest growth in investment over the whole period was ceramics (6.6% average annual growth, though with marked yearly fluctuations), followed by chemicals (2.4% average annual growth, despite a sharp decline in 2017), whereas glass investment fell at an average rate of 2.8% per annum. Cement sector investment increased at an average annual rate of 2.1%, while investment in the paper and pulp sector declined at a rate of 0.8% per annum.

Table 4-6: Investment (£ 2018 millions), 2014-2019

	2014	2015	2016	2017	2018	2019	Average % growth
Paper and pulp	446	566	531	454	431	429	-0.8%
Chemicals	877	887	852	777	927	987	2.4%
Glass	169	169	128	130	132	146	-2.8%
Ceramics	61	122	64	38	75	85	6.6%
Cement	130	165	150	160	127	144	2.1%
Metals	209	268	335	406	225	226	1.5%
Foundation Industries	1,892	2,176	2,060	1,964	1,917	2,017	1.3%
Manufacturing	17,841	20,818	18,818	18,984	19,544	19,409	1.7%
Non-financial economy	157,672	167,316	176,385	157,398	157,656	160,260	0.3%

Note: data for 2019 is estimated using MDM. Totals may not sum accurately due to rounding
Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

[22] The investment figures will capture large single investments but the data are not sufficiently granular to identify specific cases where increases in investment have been driven by a single large investment.

Foreign Direct Investment

4.33 Table 4-7 shows (inward) Foreign Direct Investment (FDI) in the foundation industries.[23] The available sectoral data do not provide enough granularity to identify FDI for each individual sector. FDI in textiles and wood activities (which includes the paper and pulp sector) increased significantly in 2017, and declined thereafter, to only £26 million in 2019. **FDI in petroleum, chemicals, pharmaceuticals, rubber and plastic products (which includes the chemicals sector) followed a sharp downward trend over 2016-19, declining by 85%** over the whole period. FDI in metal and machinery products (which includes the metals sector) declined by 60% in 2019 compared to its peak in 2017. FDI contributes sizeably to petroleum, chemicals, pharmaceuticals, rubber, and plastic products, where it accounted for between 10% to 16% of GVA produced in those sectors over 2016-19.

Table 4-7: Foreign Direct Investment

		2016	2017	2018	2019	Average % growth (across 2017-19)
£ million	Textiles & wood activities	-620	1,895	593	26	-88.3%[24]
	Petroleum, chemicals, pharmaceutical, rubber, plastic products	4,721	3,045	2,752	694	-52.3%
	Metal and machinery products	-178	1,300	1,256	525	-36.5%
% of GDP	Textiles & wood activities	-4%	13%	4%	-4%	-
	Petroleum, chemicals, pharmaceuticals, rubber, plastic products	16%	10%	10%	16%	-
	Metal and machinery products	-1%	4%	4%	-1%	-

Note: Data presented at a more aggregated SIC level of granularity than UKRI foundation industry sector definitions due to data limitations. SIC correspondence: Textile & wood activities SIC 13, 14, 16, 17, 18; Petroleum, chemicals, pharmaceuticals, rubber, plastic products SIC 19, 20, 21, 22; Metal and machinery products SIC 24, 25, 28. Negative values represent a net disinvestment in the UK. Average growth is calculated over 2017-19 because the data for 2016 are negative for two out of three of the groupings.

Source: ONS Foreign direct investment (FDI) involving UK companies.

[23] Table 4-7 presents inward FDI. Inward FDI measures investments made in the UK by foreign investors. There can be both inflows (purchases of UK assets) and outflows (disposals of UK assets or reverse investments) of inward FDI. Inward FDI is usually present on net bases, so the data are calculated by subtracting net outflows from net inflows. Inflows of inward FDI are investments in the UK by foreign investors. Outflows are disinvestments (disposal of assets to a third parts) or reverse investments (where the UK entity acquires assets of the foreign entity or provides a loan to the foreign entity). Outward FDI is not included in this table. Outward FDI measures investment by UK investors into foreign markets.

[24] The negative values in this table means that disinvestment and/or reverse investments in UK sectors in 2016 exceeded investment in UK sectors by that amount or that (net) foreign ownership of UK assets fell by a specified amount in 2016.

Exports and imports

4.34 Table 4-8 shows the evolution of real exports in the foundation industries during the period 2014-19. Exports of the foundation industries sector followed a broadly increasing trend over 2014-19 but the volume of exports in 2019 was similar to 2014 levels. Chemicals was the sector which accounted for the largest share of the foundation industries' exports in each year, typically around two-thirds, followed by metals[25], while the other sectors combined accounted for less than 15% on average over the 2014-19 period. Cement is the sector where exports grew the most in relative terms, with average annual growth of 8.2%[26], followed by glass with an average annual growth of 6.7%. Exports in metals declined on average during the period, at an average annual rate of -3.8%. This decline was driven by a particularly large fall in exports over 2015-16, perhaps linked to the closure of the SSI Redcar steelworks in late 2015, which was one of the UK's largest steel exporters. For paper and pulp, exports picked up in 2016 and 2017, before falling in the subsequent years to a similar level in 2019 as in 2014.

Table 4-8 Exports (£ 2018 millions), 2014-19

	2014	2015	2016	2017	2018	2019	Average % growth
Paper and pulp	2,397	2,220	2,580	2,523	2,468	2,370	-0.2%
Chemicals	14,941	17,295	17,150	16,927	17,178	17,229	2.9%
Glass	585	600	792	793	795	810	6.7%
Ceramics	305	301	368	372	375	363	3.5%
Cement	78	83	111	117	116	115	8.2%
Metals	36,299	39,502	23,314	26,843	36,503	30,892	-3.2%
Foundation Industries	54,605	60,001	44,314	47,575	57,434	51,778	-1.1%

Note: data for 2019 is estimated using MDM. Totals may not sum accurately due to rounding. The precious metals sub-sector has been excluded from the metals sector data.
Source: Eurostat Comext and Cambridge Econometrics (MDM-E3)

4.35 Table 4-9 shows the evolution of real imports in the foundation industries during the period 2014-19. **Import growth averaged 2.5% per annum for the foundations industries sector, but the pattern was mixed**. Imports declined slightly over 2014-15 before increasing significantly over 2015-17 and remaining broadly stable over 2018-19. The increase over 2015-17 was mainly due to the chemicals and metals sectors. As in the case of exports, metals and chemicals accounted for the largest share of imports over 2014-19, although paper and

[25] Trade figures for the metals sector do not include the precious metals production sub-sector, because trade statistics for this sub-sector are distorted by gold trading (due to London's role as a gold trading hub, UK trade statistics are regularly distorted by gold trading).
[26] The EU is by far the UK cement sector's biggest export market and cement exports to the EU are driven by industrial activity in the EU. UK cement exports over 2002-19 followed a similar trend to EU27 production.

pulp alone accounted for almost 20% for most of the period. Cement imports grew the most in relative terms, with an average annual growth rate of 10.7%, followed by glass and ceramics with an average annual growth rate of 6% each

Table 4-9: Imports (£ 2018 millions), 2014-19

	2014	2015	2016	2017	2018	2019	Average % growth
Paper and pulp	6,693	6,525	7,132	6,775	6,901	6,690	0.0%
Chemicals	16,124	15,666	16,894	18,657	19,307	19,017	3.4%
Glass	1,105	1,154	1,506	1,550	1,419	1,461	5.8%
Ceramics	973	1,059	1,290	1,213	1,163	1,289	5.8%
Cement	237	254	324	338	351	394	10.7%
Metals	26,501	25,344	61,398	44,634	34,295	70,872	21.7%
Foundation Industries	51,633	50,001	88,543	73,168	63,437	99,724	14.1%

Note: data for 2019 is estimated using MDM. Totals may not sum accurately due to rounding. The precious metals sub-sector has been excluded from the metals sector data.
Source: Eurostat Comext and Cambridge Econometrics (MDM-E3)

4.36 Table 4-10 shows the evolution of UK foundation industries exports in total world exports in 2014-19. Of the UK foundation industry sectors, the chemicals sector had the strongest presence in terms of exports on the global market,with an average share of 2.4% in 2014-19. **U**K glass exports were the second largest as a proportion of total world exports, and were broadly stable over 2014-19. The shares of the other sectors in total world exports were also relatively stable, at between 1% and 2%.

Table 4-10: UK shares in total world exports, 2014-19

	2014	2015	2016	2017	2018	2019
Paper and pulp	1.8%	1.6%	1.6%	1.5%	1.5%	1.4%
Chemicals	2.4%	2.8%	2.5%	2.2%	2.2%	2.3%
Glass	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%
Ceramics	1.1%	0.9%	1.0%	1.0%	1.0%	0.9%
Cement	0.8%	0.9%	1.0%	1.1%	1.0%	1.0%
Metals	1.9%	1.7%	1.5%	1.4%	1.4%	1.4%

Note: The precious metals sub-sector has been excluded from the metals sector data
Source: UN Comtrade (Accessed via World Bank World integrated Trade Solutions (WITS))

Energy intensity

4.37 Table 4-11 shows energy intensity by the foundation industries in terajoules (TJ) per £million of real GVA. On this measure, **chemicals has the highest energy intensity among the foundation industry sectors by a large margin**. Metals also has relatively high energy

intensity at 73.7TJ in 2018 – half that of chemicals (141.1TJ in 2018) but over three times higher than the other foundation industry sectors. Energy intensity in both chemicals and metals saw little change over the period of study. The greatest falls in energy intensity were in two of the least energy intensive sectors: paper and pulp and cement. Energy intensity in the paper and pulp sector and the cement sector fell by 6.6 TJ and 9.5 TJ respectively (corresponding to a 9.1% and 8.6% average annual decline). On the other hand, glass and ceramics increased its energy intensity by 2.8 TJ (an average annual growth of 3%) over the same period. The sector coverage for the energy use indicator is not complete. However, **the data suggest that energy intensity the foundations industries sector fell by around 1.5% per annum over the period, driven by reductions in energy intensity in paper and pulp and cement**.

Table 4-11: Energy intensity (TJ per £m of real GVA), 2014-2018

	2014	2015	2016	2017	2018	Average % growth
Paper and pulp	20.9	16.1	16.4	15	14.3	-9.1%
Chemicals	142.2	135.9	136.6	141.9	141.1	-0.2%
Glass and Ceramics	22	24.6	24.1	23.9	24.8	3.0%
Cement	31.4	27	23	21.6	21.9	-8.6%
Metals	75.9	89.8	84.7	75.9	73.7	-0.7%
Foundation Industries	292.40	293.40	284.80	278.30	275.80	-1.5%

Note: Data presented at a more aggregated SIC level of granularity than UKRI foundation industry sector definitions due to data limitations. SIC correspondence: Paper and pulp SIC 17; Chemicals SIC 20.11, 20.13, 20.14, 20.15, 20.16; Glass and ceramics SIC 23.1-4, 23.7-9; Cement SIC 23.5-6; Metals SIC24.4-5. Totals may not sum accurately due to rounding
Source: ONS Energy use: by industry reallocated to final consumer and energy intensity, 1990 to 2018

Emissions intensity[27]

4.38 shows emissions intensity[28] for the foundation industries, manufacturing and the wider non-financial economy. Emissions intensity in manufacturing and the wider non-financial economy followed a downward trend over the 2014-19 period, decreasing at average annual rates of 4% and 6% respectively. The aggregate emissions intensity of the foundation industries decreased at a faster rate, 8% per annum over 2014-19, although starting from a higher level compared to manufacturing and the wider non-financial economy. All foundation

[27] This section uses the standard definition of emissions intensity, which is typically either measured by dividing emissions by GVA or by GDP. While there are challenges to the use of this measure, emissions intensity for the overall economy is often calculated by dividing emissions by GDP. When presenting emissions intensity by sector, it is good practice to use GVA because GVA measures the value-added by the sector to the overall economy (GDP is equal to the sum of GVA across all sectors plus product subsidies and minus product axes). The ONS provides an overview of emissions intensity here.
[28] Emissions of greenhouse gases under the Kyoto protocol per unit of GVA.

industries followed a downward trajectory in emissions intensity, with cement, the foundation industry with the highest level of emissions intensity, reducing at an average annual rate of 24%. Despite the decline, all foundation industries still have higher emission intensities compared to manufacturing and the wider non-financial economy.

Table 4-12: Emission intensity (thousand tonne of CO2 per £1m of real GVA)

	2014	2015	2016	2017	2018	2019	Average % growth
Paper and pulp	0.8	0.6	0.6	0.7	0.6	0.6	-7%
Chemicals	2.1	2.3	2.2	2.3	1.9	1.8	-3%
Glass and Ceramics	1.9	1.6	1.6	1.5	1.5	1.4	-6%
Cement	29.2	8.0	8.1	9.0	8.0	7.4	-24%
Metals	12.7	10.0	9.4	7.2	8.3	8.2	-8%
Foundation Industries	3.9	3.4	3.0	2.9	2.7	2.6	-8%
Manufacturing	0.6	0.6	0.5	0.5	0.5	0.5	-4%
Non-financial economy	0.4	0.4	0.4	0.3	0.3	0.3	-6%

Note: data for 2019 is estimated using MDM.
Source: ONS (Annual Business Survey, GHG emission in the UK) and Cambridge Econometrics (MDM-E3)

Reflections

4.39 **Examination of the individual sectors reveals their heterogeneity**, with contrasting trends in key metrics. For instance, chemicals stand out as the largest sector within the foundation industries in terms of GVA, turnover, GOS, and with the highest labour productivity (as defined by GVA/worker). Paper and pulp is the second largest sector in terms of GVA, turnover and GOS as well as being largest employer. However, chemicals generally shows increasing trends for these metrics, whilst paper and pulp is declining. Metals is also characterised by a decline in GVA, GOS, and labour productivity, despite being the sector which accounts for the highest share of export and imports among the foundation industries (preceded by chemicals) and had the largest growth in employment. Generally, trends in employment for the individual sectors did not match their individual trends in GVA and turnover, perhaps because employment is slower to respond to market changes. Among the smaller foundation industries, cement experienced a significant growth in GVA, turnover, GOS and labour productivity, driven by the ready-mixed concrete sector in 2015. Ceramics and glass also experienced a noticeable growth in GVA, turnover and GOS. **By emphasising the diversity of the sectors, the data highlight the need for the TFI Challenge to be responsive to these differences.**

4.40 To some extent, there is an encouraging context for the TFI Challenge, represented by an increase in R&D spend by all six sectors over 2014-19, even when GVA declined or grew slowly. This suggests that all sectors are aware of the need for innovation and are willing to

invest. However, the need for longer-term investment, a key challenge for the FI because of high capital costs and long investment cycles, is evident in the largely declining trend in investment: total foundation industries investment in 2019 was lower than the level of investment in 2015. These data support the hypothesis that the sectors recognise the value of innovation but struggle to commit to significant investment because of the long timeframe to returns. More concerning is the decline in FDI across all sectors over this period, suggesting that circumstances for FDI are becoming less favourable for the UK.

4.41 **The picture for energy intensity (TJ/£m GVA) is also moderately encouraging for the Challenge** with energy intensity falling by 1.5% per annum across the sector as a whole. The aggregate emissions intensity of the foundation industries decreased at a faster rate than the manufacturing sector as a whole, averaging 8% per annum over 2014-19, although starting from a higher level. This was driven by a downward trajectory in emissions intensity for all six sectors. That said, the foundation industries still had significantly higher levels of emission intensity in 2019 than the whole manufacturing sector. **This highlights the continuing importance of further reducing energy intensity in the foundation industries given their significant contribution to emissions.**

4.42 Applying some caution based on the relatively short time period covered by this baseline, we can conclude that foundation industries follow dynamics that tend to diverge from the whole manufacturing sector. **On some measures, the foundation industries are performing better than manufacturing as a whole**: in terms of GVA, turnover, GOS and employment, foundation industries showed a generally increasing trend, while manufacturing was either increasing at a slower rate or declining (e.g. in GVA or GOS). Labour productivity was higher in the foundation industries than in manufacturing. However, **foundation industries lagged behind manufacturing in terms of investment growth.** While it may be true that the foundation industries have longer investment cycles than other parts of manufacturing, this is unlikely to skew the data significantly as different firms will initiate new investment cycles at different times. Thus the lower investment growth compared to manufacturing may highlight the challenge of high capital costs and long investment cycles already recognised as part of the rationale for the Challenge (which is looking to de-risk investment rather than provide substantial investment) and the need for increased investment to speed up the transition to low-carbon production processes.

International comparison

4.43 This section compares performance of the UK foundation industries with those in Belgium, France and Germany. The evidence on international comparison provides additional contextual evidence to inform the evaluation of TFI. It will not infer direct causal links between the Challenge and differences in performance between the UK foundation industries and the comparators.

Comparison of key performance metrics

4.44 The following tables present performance on the following key indicators by each foundation industry sector in Belgium, France, Germany and the UK in 2018:

- Employment
- Employment cost
- GVA
- Investment
- Labour productivity[29]
- Turnover
- Consumption of energy products.

4.45 Data were collected from the Eurostat Structural Business Statistics with 2018 as the latest available year[30]. As the data are only a snapshot of performance in one year, some caution must be applied in interpreting results. Data from a different year may have indicated different respective performance between countries.

Paper

4.46 Table 4-13 shows the performance of the paper and pulp sector among the selected countries. The sector carried broadly the same weight in the respective national economies in terms of employment, employment costs, GVA, investment and turnover in 2018, accounting for less than 1%. However, the **UK sector was both the least productive and the most energy intensive of the four countries**. In the paper and pulp sector real labour productivity stood at 68 thousand euros of GVA per worker in 2018, 8 thousand euros per worker lower than in the second least productive sector in France. UK paper and pulp energy intensity stood at 0.19

[29] As a measure that can usually be obtained/derived quite readily, labour productivity is a common and well established measure of productive efficiency and competitiveness. Labour productivity comparisons between countries are useful to compare the amount of value added per worker between sectors, across time, between countries etc. For instance, while countries and their environments may differ, comparing the same sector in two countries may be preferable to comparing two dissimilar sectors in the same country. There can be challenges in making comparisons if different countries use different methodologies or definitions to construct their labour productivity statistics. For this report, the international comparisons use data from Eurostat, which is collected by each country's national statistics office in accordance with a common set of guidelines and is further processed by Eurostat to make sure the data are harmonized. This improves the consistency and validity of comparing labour productivity across countries. Labour productivity comparisons between countries can be skewed by variation in purchasing power between countries. The comparators used in this report have very similar purchasing power to the UK so this is unlikely to affect the comparison.

[30] The data are provided to Eurostat by each country's National Statistics Office. In most countries a combination of survey and administrative data is used rather than company returns. The data are available for 4-digit level NACE codes.

euros of energy product consumed per euro of GVA, with France the second highest in energy intensity at 0.17. It is worth noting however, that this is a value-based measure and so will reflect the price of energy in each country and the energy contracts foundations industries firms agree, as well as efficiency of production in each sector in each country.[31]

Table 4-13: Paper and pulp, international comparison, 2018

	Belgium	France	Germany	UK
Employment (% of non-financial economy)	0.4%	0.4%	0.5%	0.3%
Consumption of energy products (€ per € of GVA)	0.12	0.17	0.16	0.19
Real employment cost (% of non-financial economy)	0.5%	0.5%	0.7%	0.4%
Real GVA (% of non-financial economy)	0.4%	0.5%	0.7%	0.3%
Real investment (% of non-financial economy)	0.3%	0.4%	0.7%	0.3%
Real labour productivity (€2018 thousands of GVA per worker	94	76	84	68
Real turnover (% of non-financial economy)	0.5%	0.5%	0.7%	0.4%

Source: Eurostat (Structural Business Statistics)

Chemicals

4.47 The UK chemicals sector represented a smaller share of the wider non-financial economy compared to the other countries in terms of employment (0.2%), employment cost (0.4%), GVA (0.5%), investment (0.5%), and turnover (0.5%) in 2018, as shown in

4.48 Table 4-14. The UK chemicals sector was the least energy intensive[32] (with 0.13 euros of energy products consumed per euro of GVA produced), while labour productivity was higher compared to Germany and France (158 thousand euros of GVA per worker), but lower than in Belgium.

[31] The countries selected for comparison are more likely to produce similar products to the UK industry. However, this indicator does not control for differences in energy prices between countries, which limits the validity of the comparison. No consistent measure of energy intensity in units of energy per unit of GVA was available at the required level of sectoral detail.

[32] For all the sector analyses in this section, this is a value based measure and so will reflect the price of energy in each country and the energy contracts foundations industries firms agree, as well as efficiency of production in each sector in each country.

Table 4-14: Chemicals, international comparison, 2018

	Belgium	France	Germany	UK
Employment (% of non-financial economy)	1.0%	0.5%	0.8%	0.2%
Consumption of energy products (€ per € of GVA)	0.24	0.18	0.17	0.13
Real employment cost (% of non-financial economy)	2.6%	0.9%	1.6%	0.4%
Real GVA (% of non-financial economy)	3.0%	1.1%	1.7%	0.5%
Real investment (% of non-financial economy)	2.9%	0.8%	1.9%	0.5%
Real labour productivity (€2018 thousands of GVA per worker	221	126	133	158
Real turnover (% of non-financial economy)	2.7%	1.1%	1.8%	0.5%

Source: Eurostat (Structural Business Statistics)

Glass

4.49 The UK glass sector was broadly in line with the other countries, accounting for 0.1% of the wider non-financial economy in terms of employment, employment costs, GVA, investment and turnover (see Table 4-15, which shows the performance of the glass sector within the selected countries). **It consumed the highest amount of energy product per unit of GVA (0.25 euros per euro of GVA) among the countries considered**, followed by Belgium (0.22 euros per euro of GVA), **and was also the least productive** with 62 thousand euros of GVA per workers, followed by France with 69 thousand euros per worker.[33]

Table 4-15 Glass, international comparison, 2018

	Belgium	France	Germany	UK
Employment (% of non-financial economy)	0.2%	0.2%	0.2%	0.1%
Consumption of energy products (€ per € of GVA)	0.22	0.19	0.18	0.25
Real employment cost (% of non-financial economy)	0.4%	0.3%	0.2%	0.1%

[33] Note differences in productivity between countries could be due to differences in product mix but the data are not sufficiently detailed to show this. To mitigate the risk that the comparator country TFI sectors produce different products, we chose countries that export a high proportion of their total exports to the UK, on the basis that these countries are more likely to produce goods that UK producers are directly competing to sell on the domestic market.

	Belgium	France	Germany	UK
Real GVA (% of non-financial economy)	0.3%	0.3%	0.2%	0.1%
Real investment (% of non-financial economy)	0.1%	0.2%	0.2%	0.1%
Real labour productivity (€2018 thousands of GVA per worker	98	69	71	62
Real turnover (% of non-financial economy)	0.3%	0.2%	0.2%	0.1%

Source: Eurostat (Structural Business Statistics).

Ceramics

4.50 The ceramics sector accounted for around 0.1% of wider non-financial economy employment, employment cost, GVA, investment and turnover in all countries (see

4.51 Table 4-16). **The UK ceramics sector was the least energy intensive among the countries considered** with 0.12 euros of energy products consumed per euro of GVA, followed by Germany with 0.17. **It was also the second most productive** with 104 thousand euros of GVA per worker, surpassed by a small margin by Belgium at 111 thousand of euros of GVA per worker.

Table 4-16: Ceramics, international comparison, 2018

	Belgium	France	Germany	UK
Employment (% of non-financial economy)	0.1%	0.1%	0.1%	0.1%
Consumption of energy products (€ per € of GVA)	0.21	0.18	0.17	0.12
Real employment cost (% of non-financial economy)	0.1%	0.1%	0.1%	0.1%
Real GVA (% of non-financial economy)	0.1%	0.1%	0.1%	0.1%
Real investment (% of non-financial economy)	0.1%	0.1%	0.1%	0.0%
Real labour productivity (€2018 thousands of GVA per worker	111	65	59	104
Real turnover (% of non-financial economy)	0.1%	0.1%	0.1%	0.1%

Source: Eurostat (Structural Business Statistics)

4.52 Cement

4.53 Table 4-17 shows the international comparison for the cement sector among the selected countries. The cement sector in the UK accounted for 0.1% of the wider non-financial economy in terms of employment, employment costs, GVA, Investment and turnover, a share comparable to France and Germany but slightly lower than Belgium. **The UK cement sector was the least energy intensive among the countries considered** with 0.1 euros of energy products consumed per euro of GVA, followed closely by France with 0.15. **However, it was also the least productive** with 82 thousand of GVA per worker, followed by Germany at 85 thousand euros of GVA per worker.

Table 4-17 Cement, international comparison, 2018

	Belgium	France	Germany	UK
Employment (% of non-financial economy)	0.2%	0.1%	0.1%	0.1%
Consumption of energy products (€ per € of GVA)	0.25	0.15	0.24	0.10
Real employment cost (% of non-financial economy)	0.4%	0.2%	0.2%	0.1%
Real GVA (% of non-financial economy)	0.3%	0.2%	0.2%	0.1%
Real investment (% of non-financial economy)	0.4%	0.2%	0.2%	0.1%
Real labour productivity (€2018 thousands of GVA per worker	115	98	85	82
Real turnover (% of non-financial economy)	0.2%	0.2%	0.1%	0.1%

Source: Eurostat (Structural Business Statistics), ONS (Annual Business Survey) for the UK

4.54 Metals

4.55 Table 4-18 shows the performance of the metals sector within the selected countries. The metals sector in the UK accounted for 0.2% of the wider non-financial economy employment, employment cost, GVA and investment, and for 0.3% of turnover, the smallest share among the countries considered. As with the paper and pulp sector and the glass sector, **it had the lowest labour productivity** (61 thousand euros of GVA per worker, followed by France at 91) **and the highest energy use** (0.32 euros of energy products consumed per euro of GVA, after France at 0.31) compared to the other countries.

Table 4-18: Metals, international comparison, 2018

	Belgium	France	Germany	UK
Employment (% of non-financial economy)	0.6%	0.3%	0.5%	0.2%
Consumption of energy products (€ per € of GVA)	0.27	0.31	0.27	0.32
Real employment cost (% of non-financial economy)	1.3%	0.4%	0.8%	0.2%
Real GVA (% of non-financial economy)	1.0%	0.4%	0.8%	0.2%
Real investment (% of non-financial economy)	0.6%	0.4%	0.7%	0.2%
Real labour productivity (€2018 thousands of GVA per worker)	129	91	95	61
Real turnover (% of non-financial economy)	1.7%	0.7%	1.3%	0.3%

Source: Eurostat (Structural Business Statistics)

Patents

4.56 Table 4-19 shows the number of patents by foundation industry sector in the different countries. Across all sectors, Germany issued the most patents, followed by France, the UK and Belgium. This indicates that the UK lags on this measure of innovative activity within the FIs compared to Germany and France. This result can be partially linked to the smaller weight in the overall UK economy (e.g. in terms of employment and GVA) of sectors such as chemicals and metals, while in sectors whose dimension is similar across all four countries, such as glass, ceramics and cement, the fewer number of patents issued in the UK reflects weaker innovation. There may also be national business or cultural factors influencing these measures, which can be explored through other aspects of the evaluation, such as the qualitative research.

Table 4-19: Number of patents by TFI, 2017

	Belgium	France	Germany	UK
Paper and pulp	2	12	18	3
Chemicals	253	1,133	1,865	663
Glass, ceramics and cement	39	157	267	57
Metals	16	79	145	28

Note: Data presented at a more aggregated SIC level of granularity than UKRI foundation industry sector definitions due to data limitations. The correspondence is based on a mapping between the IPC v8 classification and the NACE classification, see https://ec.europa.eu/eurostat/ramon/documents/IPC_NACE2_Version2_0_20150630.pdf .
Source: OECD Patents by technology

Conclusions

4.57 The table below sums up the UK's rankings of the four countries in terms of three of the indicators reported on above: labour productivity, energy use and innovation (as measured by patents). The rankings should be considered with caution due to the issues that can affect country performance on the same metrics but may be indicative of relative performance.

Table 4-20: UK ranking in performance of FI sectors of the UK, Belgium, France and Germany , 2018

	Labour productivity	Energy use	Innovation
Metals	4	4	3
Paper and pulp	4	4	3
Glass	4	4	3
Cement	4	1	3
Ceramics	2	1	3
Chemicals	2	1	3

Source: CE analysis

4.58 The data show that **four of the UK's six foundation industries sectors (namely paper and pulp, glass, metals and cement) were the least productive** among the countries considered. The UK ranked second of the four countries in terms of the other two sectors, chemicals and ceramics.

4.59 **Energy use presents a mixed picture**: the chemicals, ceramics and cement sectors had the lowest energy use in the UK, while paper and pulp, glass and metals had the highest.

4.60 In terms of the number of patents issued, the UK is similar to the comparator countries in the chemicals and metals sector, once the relative size of the industry is taken into account, while it lags in glass, ceramics and cements.

4.61 Overall, the international comparison indicates that, despite some strengths (notably the chemicals sector), **there is scope for UK foundation industries to catch-up with their peers in competitor countries**. This validates the case for the TFI ISCF and points to particular need for support for the glass, paper and pulp, and metals sectors, although with the caveat that the data represent a snapshot of performance in 2018.

Baseline projections

4.62 This section presents projections for the foundation industries up to 2040 on economic and energy metrics (GVA, employment, labour productivity and emissions) assuming the absence of the TFI programme. The modelling provides a conservative perspective of the potential trajectory of the FI, and is not able to easily accommodate potential future disruptions. The scenario analysis explores qualitatively how such disruptions or more extreme trends might

play out. The projections presented below are best considered as a quantitative description of the 'business as usual' scenario.

GVA

4.63 Real GVA in the foundation industries is expected to grow at an average annual rate of 1.4% over 2019-30, before slowing down over 2030-40 to 0.8% per annum on average. Manufacturing and the wider non-financial economy are expected to grow at a slower pace over 2019-30 (0.8% and 1% average annual growth respectively), but to surpass foundation industries average annual growth rates over 2030-40 (1.2% and 1.4% respectively).

4.64 Chemicals is the foundation industry sector for which GVA is expected to grow the fastest through the projection period, with an average annual growth rate of 2.2% over 2019-30 and 1.2% over 2030-40, followed by glass with an average annual growth rate of 1.3% over 2019-30 and 0.8% over 2030-40. The other foundation industry sectors are expected to grow at an average annual growth rate of less than 1% over the projection period.

4.65 The levels projections for 2019, 2030 and 2040 are provided in

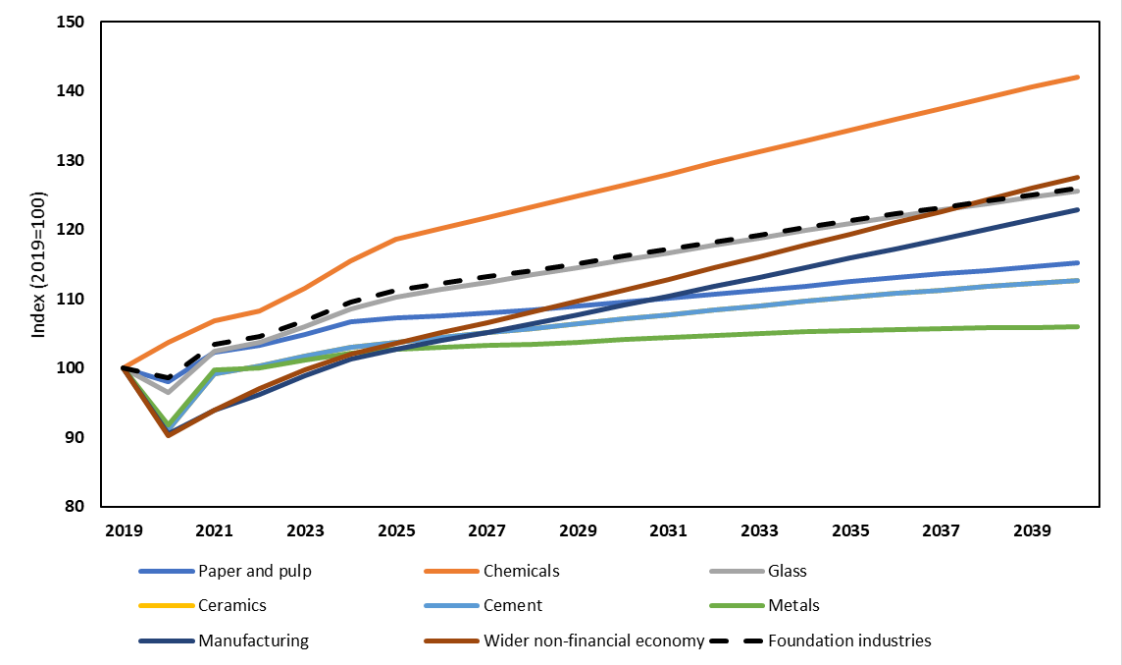
4.66 Table 4-21, with the projection over time (indexed to 2019) shown in Figure 4-1.

Table 4-21: Real GVA projections to 2040

	Levels (£ 2018 millions)			Growth (% pa)		
	2019	**2030**	**2040**	**2014-19**	**2019-30**	**2030-40**
Paper and pulp	3,367	3,689	3,881	-4%	0.8%	0.5%
Chemicals	5,765	7,287	8,188	3%	2.2%	1.2%
Glass	1,089	1,259	1,368	6%	1.3%	0.8%
Ceramics	974	1,043	1,097	8%	0.6%	0.5%
Cement	1,165	1,247	1,312	24%	0.6%	0.5%
Metals	1,385	1,443	1,468	-7%	0.4%	0.2%
Foundation industries	13,744	15,969	17,314	1.2%	1.4%	0.8%
Manufacturing	166,224	181,336	204,163	-0.2%	0.8%	1.2%
Wider non-financial economy	1,296,479	1,442,491	1,654,186	2.2%	1.0%	1.4%

Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Figure 4-1: Real GVA projections to 2040



Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Employment

4.67 The foundation industries are expected to lose 37,000 jobs over 2019-40, corresponding to an average annual decline of 1%, following a trajectory similar to that of the manufacturing sector. In contrast, employment is expected to grow at around 0.5% per annum on average in the wider non-financial economy.

4.68 Employment is expected to decline overall in all of the foundation industry sectors. Ceramics and cement are expected to experience the sharpest contraction, with employment declining at an average annual rate of 1.3% over 2019-30 and 2.1% over 2030-40. The largest employment decline in absolute levels is expected in chemicals, with 8,000 jobs lost through the projection period.

4.69 The levels projections for 2019, 2030 and 2040 are provided in Table 4-22, with the projection over time (indexed to 2019) shown in Figure 4-2.

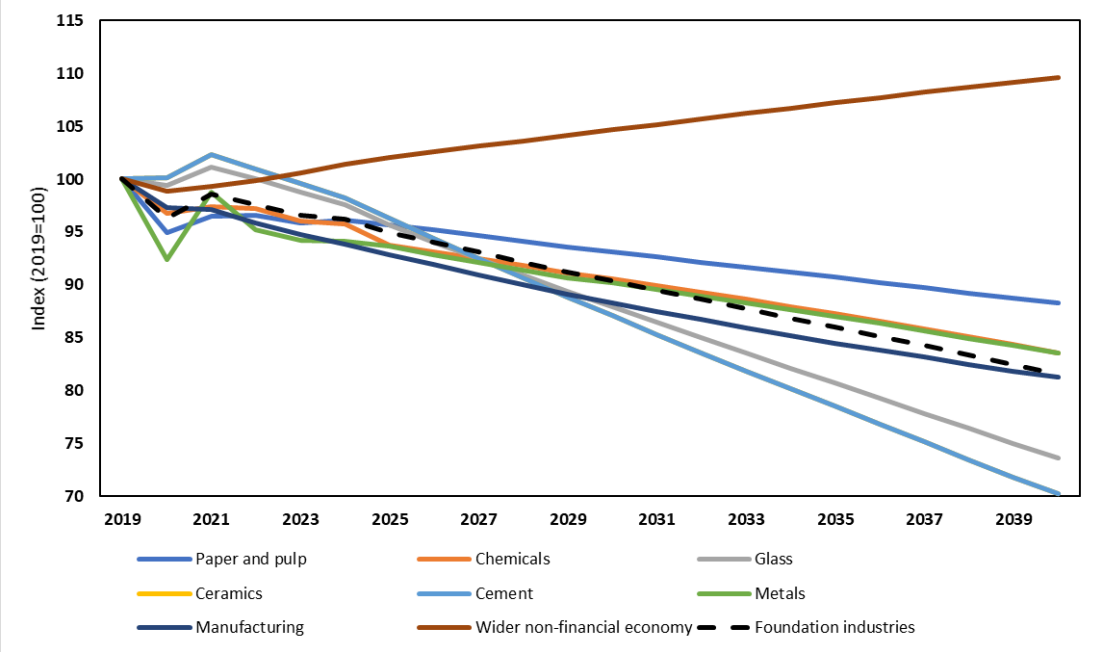
Table 4-22: Employment projections to 2040

	Levels (000s)			Growth (% pa)		
	2019	2030	2040	2014-19	2019-30	2030-40
Paper and pulp	60	56	53	1%	-0.6%	-0.5%
Chemicals	49	44	41	1%	-0.9%	-0.8%
Glass	22	19	16	2%	-1.2%	-1.8%
Ceramics	17	15	12	4%	-1.3%	-2.1%
Cement	18	15	12	0%	-1.3%	-2.1%

	Levels (000s)			Growth (% pa)		
Metals	36	32	30	3%	-0.9%	-0.8%
Foundation industries	201	182	164	1.6%	-0.9%	-1.0%
Manufacturing	2,532	2,236	2,057	0.3%	-1.1%	-0.8%
Wider non-financial economy	25,013	26,182	27,425	2.1%	0.4%	0.5%

Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Figure 4-2: Employment projections to 2040



Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Labour productivity

4.70 Real labour productivity is expected to grow at an average annual rate of 2.3% over 2019-30 and 1.8% over 2030-40, slightly faster than in the wider manufacturing sector and at least double the rate of growth in the wider non-financial economy.

4.71 All foundation industry sectors are projected to increase their labour productivity. Labour productivity in the chemicals sector is expected to grow the fastest over 2019-30 at an average annual rate of 3.1%, while over 2030-40, labour productivity in the glass, ceramic and cement sectors is expected to increase the most at around 2.7% per annum on average. Chemicals is expected to remain by a great margin the most productive sector, followed by cement, while metals is projected to remain the least productive.

4.72 The levels projections for 2019, 2030 and 2040 are provided in

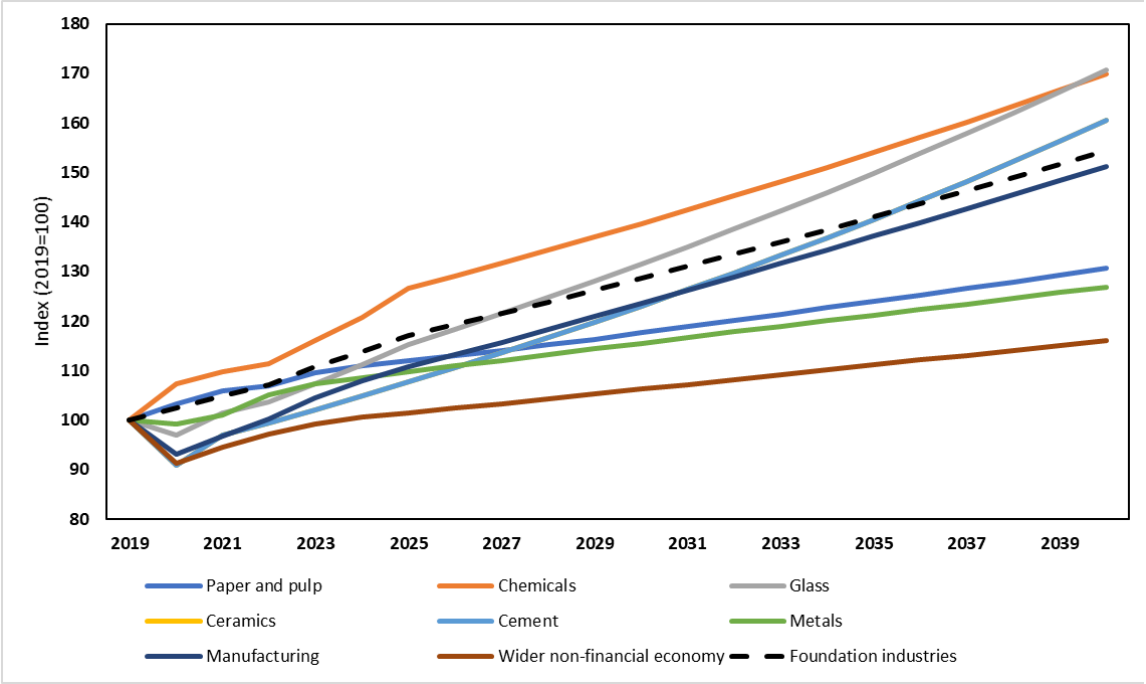
4.73 Table 4-23, with the projection over time (indexed to 2019) shown in Figure 4-3.

Table 4-23: Labour productivity projections to 2040

	Levels (£ 2018 thousands GVA per worker)			Growth (% pa)		
	2019	2030	2040	2014-19	2019-30	2030-40
Paper and pulp	56	66	74	-5%	1.5%	1.1%
Chemicals	118	165	200	2%	3.1%	2.0%
Glass	50	66	86	4%	2.5%	2.6%
Ceramics	56	69	90	4%	1.9%	2.7%
Cement	66	81	106	24%	1.9%	2.7%
Metals	39	45	49	-10%	1.3%	0.9%
Foundation industries	68	88	106	-0.4%	2.3%	1.8%
Manufacturing	66	81	99	-0.6%	1.9%	2.0%
Wider non-financial economy	52	55	60	0.1%	0.5%	0.9%

Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Figure 4-3: Labour productivity projections to 2040



Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Emissions

4.74 Emissions by the foundation industries are expected to decline at an average annual rate of 2.4% in 2019-30 and 2.2% in 2030-40, double the rate of the wide non-financial economy but below the one of manufacturing (expected to reduce its emission by 3.8% per annum in 2019-30 and 3% in 2030-40).

4.75 Most foundation industries are expected to reduce their levels of emissions. The fastest rate of emissions decline is expected in the paper and pulp sector at around 8% per annum over the whole projection period, followed by cement with a 6% reduction per annum. The cement sector is expected to show the greatest decline in levels, with a reduction of around 6,300 thousand tonnes of CO2 equivalent in 2019-2040. Emissions in the metals sector are expected to remain broadly stable over 2019-2040.

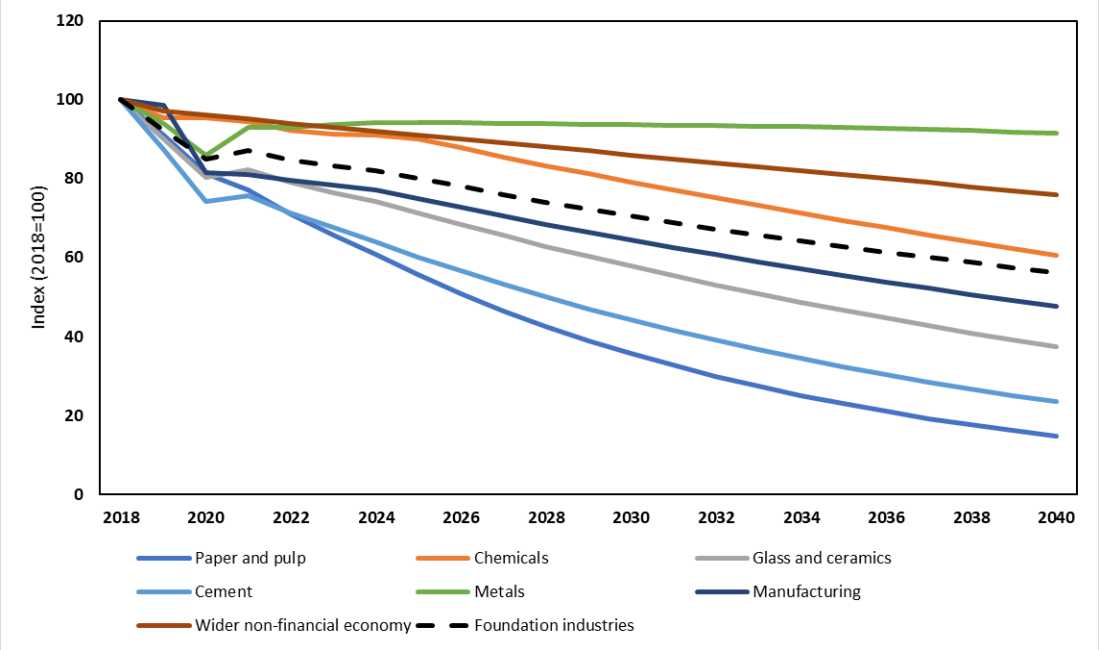
4.76 The levels projections for 2019, 2030 and 2040 are provided in Table 4-24, with the projection over time (indexed to 2019) shown in Figure 4-4.

Table 4-24: Emissions projections to 2040

	Levels (Thousand tonnes of CO2 equivalent)			Growth (% pa)		
	2019	**2030**	**2040**	**2014-19**	**2019-30**	**2030-40**
Paper and pulp	1,935	760	315	-10%	-8.1%	-8.4%
Chemicals	10,359	8,580	6,564	0%	-1.7%	-2.6%
Glass and ceramics	2,872	1,844	1,195	2%	-3.9%	-4.2%
Cement	8,673	4,393	2,340	-4%	-6.0%	-6.1%
Metals	11,423	11,384	11,123	-12%	0.0%	-0.2%
Foundation industries	35,263	26,961	21,536	-6%	-2.4%	-2.2%
Manufacturing	82,318	53,883	39,852	2%	-3.8%	-3.0%
Wider non-financial economy	405,615	359,448	317,478	3%	-1.1%	-1.2%

Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Figure 4-4: Emissions projections to 2040



Source: ONS (Annual Business Survey) and Cambridge Econometrics (MDM-E3)

Conclusions

4.77 The modelled projections provide one way of understanding the potential trajectory of the foundation industries over the next couple of decades to 2040. The model is inherently conservative as it extrapolates from existing performance into the future. The model is also informed by expert views on likely macroeconomic and market trends but there is a limit to the amount of detail that can be reflected in the projections. The advantage of the projections is that they provide a quantified description of the potential future performance of the foundation industries. In comparison, the scenarios developed for the evaluation framework provided nuanced, qualitative *possible futures* (rather than projections) for the FI. The future scenarios highlight some of the risks and opportunities for the FI and the constituent sectors and should be considered alongside the modelled projections to inform the design of interventions to support the FI.

4.78 In sum, the projections suggest that the foundation industries are expected to show stronger relative growth compared to manufacturing and the wider non-financial economy in terms of GVA for part of the projection period and in terms of labour productivity for the whole period. Both employment and emissions in the foundation industries are expected to decline, following closely the developments in manufacturing. In contrast, employment is projected to increase in the wider non-financial economy, while emissions are expected to decrease at a slower pace. The projections show a shift in what was highlighted for the period 2014-19, with the foundation industries sector losing its relative dynamism compared to manufacturing. GVA growth in the foundations industries sector broadly stagnates over the forecast horizon while GVA growth in the manufacturing sector accelerates and eventually overtakes that for foundation industries. Labour productivity growth out to 2040 is much the

same in manufacturing as it is in foundation industries. As a result, after strong employment growth over 2014-19, and much stronger than in manufacturing, employment in the foundations industries sector is expected to decline over 2019-40, at much the same rate as in manufacturing. As discussed above, the scenario analysis highlights factors that may drive or inhibit this forecast performance, such as over-reliance by the FI on the development of low-carbon technologies by other sectors.

4.79 Chemicals stands out as the sector with the greatest relative increase in GVA over the projection period, driving most of the increase for the whole foundation industries sector. All subsectors are projected to decrease in employment at broadly similar rates, while chemicals and glass are projected to reach the highest levels of productivity, compared to 2019 levels. The metals sector is projected to increase marginally in GVA during the forecast period, and to be the foundation industry with the lowest growth in labour productivity and the lowest decline in emissions. The paper and pulp sector stands out as the foundation industry with the steepest decline in emissions over the projection period.

5. Implications and next steps

5.1 The baseline report presents evidence from a business survey and secondary data analysis on the position of the FI at the point at which the TFI Challenge commenced. It highlights a number of points that support the rationale for the programme, making the case for it being a timely and important intervention. The findings in the report also point to how the Challenge might focus its efforts during delivery. This use of evidence to re-focus delivery assists the programme in its aspiration to be responsive and agile according to new insights as well as take a leadership role in helping the Foundation Industries to meet their challenges.

5.2 It is worth noting that the baseline year is 2019/20, meaning any impacts on the FI due to the Covid-19 pandemic and the impact of associated policies and restrictions are not accounted for in this report. The primary data collection methods during the process and impact evaluation phases will aim to capture evidence relating to the impacts of Covid, for example through the case study work and the second wave of the business survey. Notwithstanding the above, we summarise the key findings and implications as follows.

- Businesses surveyed did not recognise the ceramics, glass, cement, metals, paper and chemicals sectors as 'Foundation Industries' and it was inconclusive whether businesses considered themselves as being part of FI, although a significant number did. This indicates that **the development of a shared FI 'identity' – a key aim of TFI ISCF – may have a receptive audience**. However, the secondary data analysis highlights the heterogeneity among the FI sectors (with contrasting trends in key metrics, for example chemicals generally shows increasing trends in GVA, turnover, gross operating surplus, and labour productivity whilst paper and pulp is declining) which may present some challenges to this workstream. The **real value in this workstream will be turning identity into action**, particularly in terms of increasing willingness to collaborate on shared problems, and to extend that willingness into collaboration with the research base.

- The most commonly perceived barriers to R&D and/or innovation reported by businesses were: lack of time to invest, financial risk, lack of information on private funding, cost competition from abroad, standards and regulations, lack of technical and/or innovation skills, and reluctance to collaborate with other companies in FI. Businesses that had invested in R&D and/or innovation were more likely to perceive skills, reluctance to collaborate and technical risk as being barriers to innovation than companies that had not invested. The **TFI Challenge team may find it useful to consider these barriers when planning engagement with different elements of the FI**: companies that have previously invested in R&D may need a different approach to those that have not invested.

- Survey findings in terms of investment in R&D and/or innovation show that about half of the FI have invested, with investment more common among chemical and cement companies and mainly among large, medium and small companies. This may indicate which companies in particular sectors may be easier to engage and where the Challenge

may have to put in more effort. Overall a small proportion of investment in R&D and/or innovation was from FDI, validating the Challenge objective to increase FDI.

- Around one-third of businesses collaborate with other firms (from the same and different sectors within FI). It was also found that collaboration increased with business size. TFI might want to consider how this aligns with the current profile of programme participants and how they might attract smaller companies to collaboration. Significantly, the survey clearly showed that **collaboration with the research base is much lower, underlining the rationale for a workstream dedicated to increasing industry-academic collaborations**.
- The survey evidence on net zero was encouraging to the extent that businesses generally seemed to recognise the importance of the agenda and are taking some action. However, there was a lower rate of investment in innovation to improve both energy and resource efficiency. Other research indicates that this investment is perceived to be costly and risky, likely reducing such activity. This is a demonstrable market failure in which TFI has a clear remit as a publicly funded programme to mitigate. The **awareness of and commitment to net zero indicates that there would be a receptive audience for such intervention.**
- In terms of skills, there was a clear finding from the survey that companies perceive a lack of technical and/or innovation skills: this was consistent across all six sectors. The Challenge does not have a specific workstream focused on skills but is undertaking some exploratory work on this issue, which is justified by the evidence.

5.3 The modelled projections for the foundation industries up to 2040 on economic and energy metrics (GVA, employment, labour productivity and emissions) assume the absence of the TFI programme. The results indicate a mixed picture:

- Real GVA in the foundation industries is expected to grow faster than manufacturing and the wider financial economy until 2030, but slows thereafter.
- Chemicals has the greatest relative increase in GVA over the projection period, driving most of the increase for the whole foundation industries sector.
- Employment is expected to decline overall in all of the foundation industry sectors - ceramics and cement are expected to experience the sharpest contraction.
- All foundation industry sectors are projected to increase their labour productivity, the same applies to manufacturing.
- Most FI are expected to reduce their levels of emissions, fastest rate of emissions decline is expected in the paper and pulp, followed by cement.

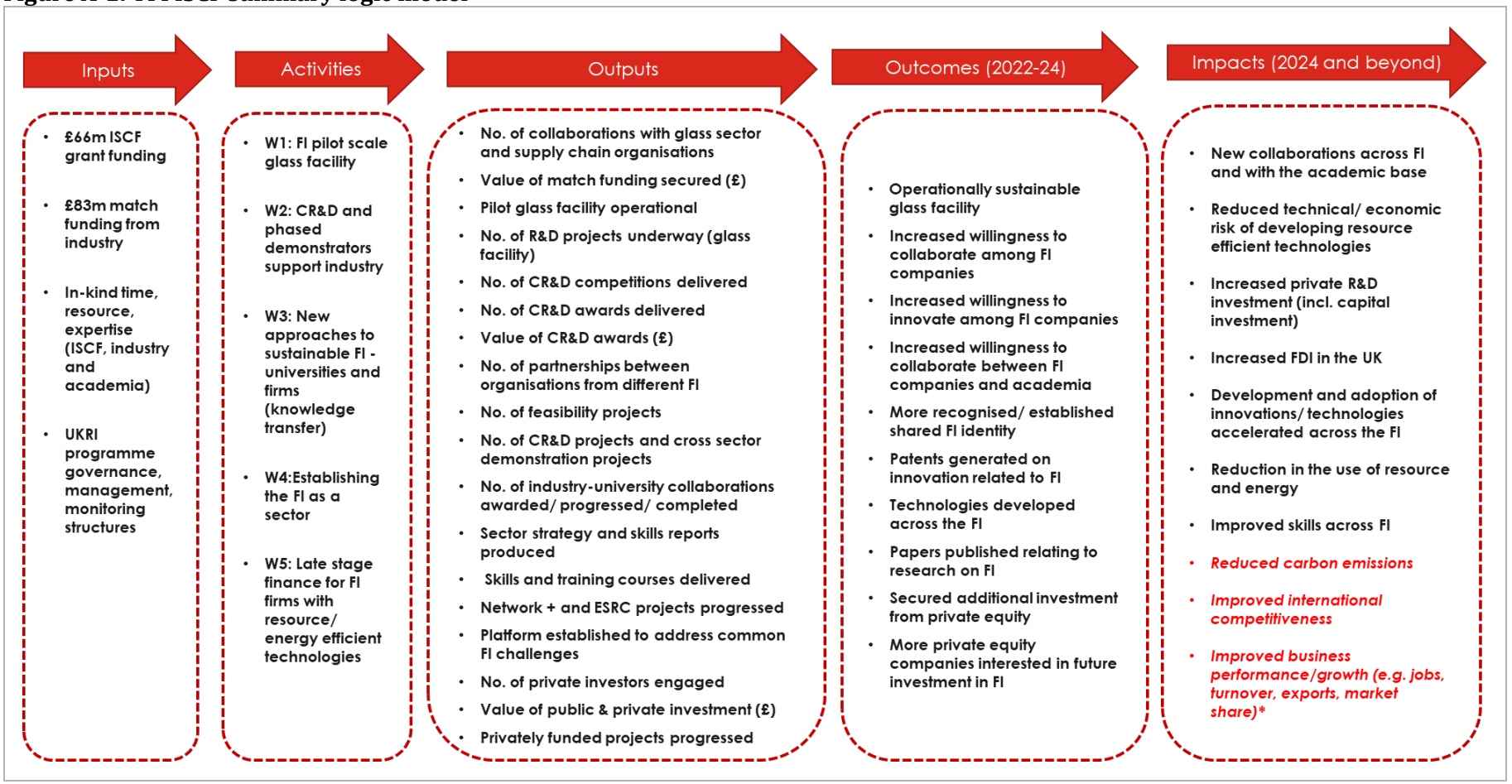
5.4 The UK's international competitiveness in FI is critical for future prosperity and sustainability. The international comparator analysis indicates that there is scope for the UK foundation industries to catch-up with their peers in competitor countries – Belgium, France,

and Germany – on various metrics. This supports the case for the TFI ISCF to assist firms across the FI, in particular glass, paper and pulp, and metals.

5.5 Finally, the contextual evidence presented in this baseline report provides the starting point against which change among the FI can be measured during later phases of the evaluation. However, it is important to note that neither the secondary data analysis nor the survey is intended to directly attribute changes (via causal links) in the FI to the TFI Challenge. However, the second survey in 2023/24 will be able to provide evidence on benefits of the programme for participants and compare them to outcomes for non-participant companies. In subsequent phases of the evaluation, the secondary data analysis will work alongside the scenario analysis to inform the development and the refinement of the Theory of Change, which underpins the evaluation approach.

Annex A: Summary logic model

Figure A-1: TFI ISCF summary logic model



Source: SQW TFI ISCF evaluation framework report.
Note: Impacts highlighted in red italics more likely to be measurable post-evaluation (beyond 2024)

Annex B: SIC codes for the Foundation Industries

B.1 The foundation industries in this report are defined using the following SIC codes (unless otherwise stated). This definition was provided by the TFI challenge team.

Table B-1: SIC codes for the Foundation Industries

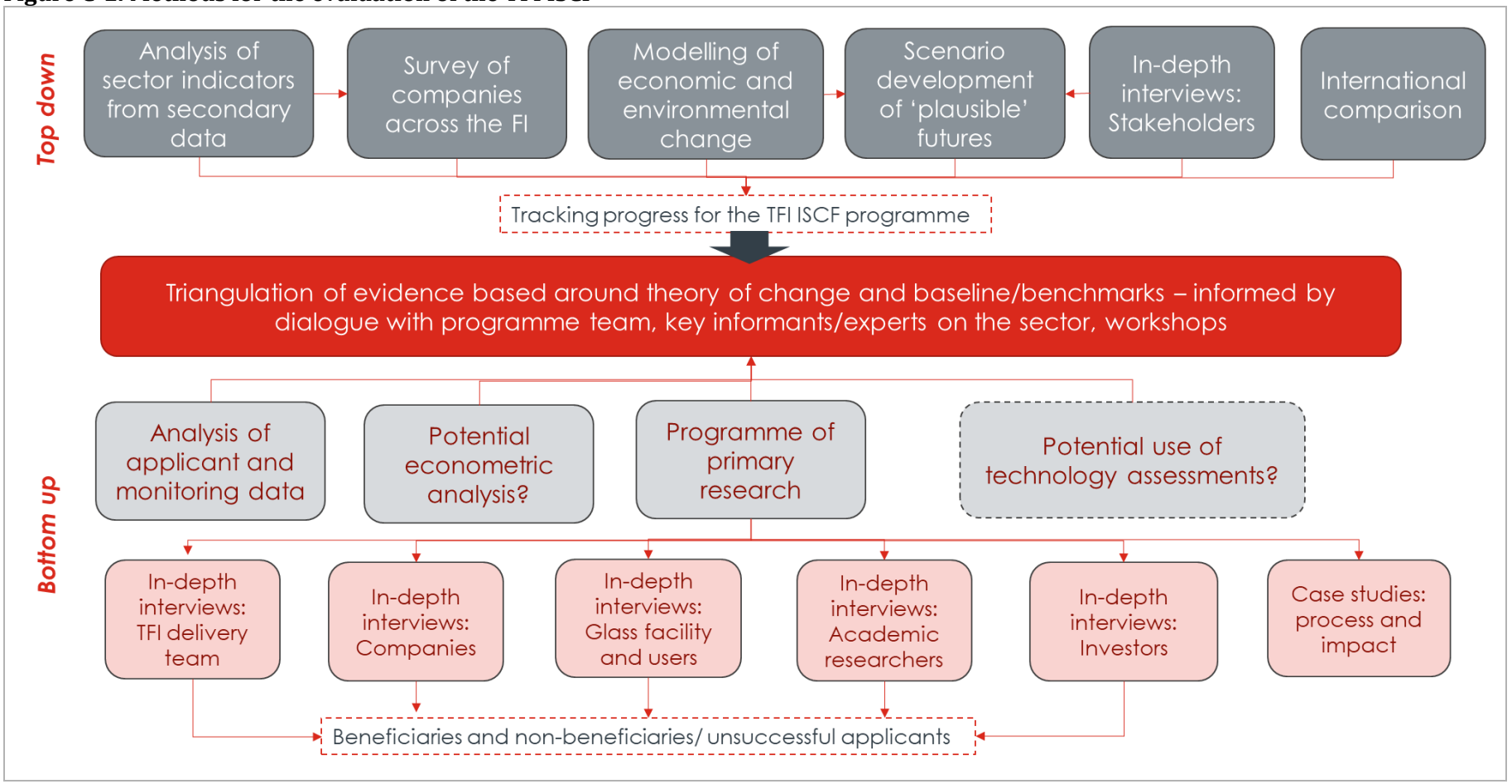
SIC Code	Description
Paper and pulp	
17110	Manufacture of pulp
17120	Manufacture of paper and paperboard
17211	Manufacture of corrugated paper and paperboard, sacks and bags
17219	Manufacture of other paper and paperboard containers
17220	Manufacture of household and sanitary goods and of toilet requisites
17230	Manufacture of paper stationery
17240	Manufacture of wallpaper
17290	Manufacture of other articles of paper and paperboard n.e.c.
Chemicals	
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.
Glass	
23110	Manufacture of flat glass
23120	Shaping and processing of flat glass
23130	Manufacture of hollow glass
23140	Manufacture of glass fibres
Ceramics	
23310	Manufacture of ceramic tiles and flags
23320	Manufacture of bricks, tiles and construction products, in baked clay

SIC Code	Description
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.
Cement	
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
Metals	
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: TFI Challenge team

Annex C: Evaluation methods

Figure C-1: Methods for the evaluation of the TFI ISCF



Source: SQW TFI ISCF evaluation framework report.

Annex D: Evaluation metrics

D.1 The table below present the metrics agreed for the evaluation of the Transforming Foundation Industries Industrial Strategy Challenge Fund.

Table D-1:

#	Indicator	Source	Responsibility	Outcome/ impact as per TFI programme logic model	Reported	Research Question
Outcomes						
1	Operationally sustainable glass facility (W1)	Programme monitoring (looking at public and private funding e.g. membership scheme)	UKRI	Increased demand for the glass facility including use by other FI (WI)	Impact report	1
2	Level of usage by member organisation of glass facility (days) (W1)	Programme monitoring (in Glass Futures KPIs), consultations with stakeholders	UKRI, SQW	Increasing demand for the glass facility including use by other FI (WI)	Impact report	1
3	Technologies accelerated to market (TRL progression) (W2)	Programme monitoring (at project closure (currently) and more frequently (as delivery progresses).	UKRI	Technologies accelerated to market (W2)	Impact report (recognising may not be significant change in programme timeframe)	1, 1c
4	Number of new technologies developed (W3)	Programme monitoring	UKRI	New technologies developed to solve cross sector issues (W3)	As above	1, 1c
5	Number of papers published relating to research on FI (W3)	Programme monitoring (in KPIs for Network+, Hub)	UKRI	Papers published relating to research on FI (W3)	As above	1a, 1b

#	Indicator	Source	Responsibility	Outcome/ impact as per TFI programme logic model	Reported	Research Question
6	Number of patents generated on innovation related to FI (W3)	Programme monitoring (at project closure)	UKRI	Patents generated on innovation related to FI (W3)	As above	1a, 1b
7	Patent applications (W3)	Secondary dataset: OECD patents by technology (for context not programme data)	SQW	Patents generated on innovation related to FI (W3)	As above	1a, 1b
8	Establishment of a shared FI identity (perceptions of internal FI and external stakeholders)	Consultations with participating firms, academics and other stakeholders (using Likert scale question about identity and/or cohesiveness); survey of companies.	SQW	Foundation industries identity established (W4)	Impact report	1b
9	Willingness among FI companies to innovate	Survey of companies, consultations with participating firms, academics and other stakeholders (including asking for relative importance of innovation compared to other business priorities)	SQW	Increased interest in innovation (WS 1-4)	Baseline and impact report	1a, 1b
10	Willingness among FI companies to collaborate	Survey of companies, consultations with participating firms, academics and other stakeholders (including asking relative importance to other priorities)	SQW	Increased interest in collaboration (WS 1-4)	Baseline and impact report	1a, 1b
11	Willingness among FI companies and academics to collaborate	Survey of companies, consultations with participating firms, academics and other stakeholders (including asking relative importance to other priorities)	SQW	Increased interest in collaboration (WS 1-4)	Baseline and impact report	1a, 1b

#	Indicator	Source	Responsibility	Outcome/ impact as per TFI programme logic model	Reported	Research Question
Impacts						
12	Number of new collaborations between companies across FI and with the academic base	Programme monitoring	UKRI	New and effective collaborations across the sectors and with the academic base	Impact report	1a, 1b
13	Value of private R&D investment on activity supported by the Challenge (£)	Programme monitoring (by WS); consultations with participating firms; end of programme surveys	UKRI, SQW	Increased private R&D investment (incl. capital investment)	Impact report	4
14	Value of private R&D investment at firm-level (£) (evidence for programme and context)	Baseline and end of programme surveys; secondary dataset	UKRI, SQW	Increased private R&D investment (incl. capital investment)	Baseline and impact report	4
15	Value of private R&D investment at wider sector level (£) (for context)	Secondary dataset	SQW	Increased private R&D investment (incl. capital investment)	Baseline and impact report	4
16	Value of private R&D investment/GVA (for context)	Secondary dataset (explore Beauhurst, potentially FAME database)	SQW	Increased private R&D investment (incl. capital investment)	Baseline and impact report	4
17	Value of foreign direct investment (FDI) secured by the Challenge (£)	Programme monitoring (by WS); consultations with participating firms, survey	UKRI, SQW	Increased FDI in the UK	Impact report	4

#	Indicator	Source	Responsibility	Outcome/ impact as per TFI programme logic model	Reported	Research Question
18	Value of FDI secured at firm level (£) (for context)	Potentially secondary dataset (2 digit SIC code) (Beauhurst); survey	SQW	Increased FDI in the UK	Baseline and impact report	4
19	Value of FDI secured at wider sector level (£) (for context)	Secondary dataset	SQW	Increased FDI in the UK	Baseline and impact report	4
20	Value of FDI/GVA (£) (for context)	Secondary dataset	SQW	Increased FDI in the UK	Baseline and impact report	4
21	Technologies developed and adopted across the FI – progression through TRLs	Programme monitoring	UKRI	Development and adoption of innovations/technologies accelerated across the FI	Impact report	1, 1c
22	Amount of material used by industry	Programme monitoring (asking if project would lead to % reduction in amount of material used. Note, challenging to standardise across firms using different materials so may quantify by type of material).	UKRI	Reduction in the use of resource and energy	Impact report	2
23	Energy consumption by industry	Secondary dataset: ONS, energy use by industry, source	SQW	Reduction in the use of resource and energy	Baseline and impact report	2
24	Emissions intensity (GHG emissions per real unit of GVA)	Secondary dataset: ONS Environmental Accounts	SQW	Reduced carbon emissions	Baseline and impact report	2
25	Number of skills shortages (vacancies) at firm level	Baseline and end of programme surveys	UKRI, SQW	Improved skills across FI	Impact report	3

#	Indicator	Source	Responsibility	Outcome/ impact as per TFI programme logic model	Reported	Research Question
26	Incidence of skills shortages (vacancies) at sector level	Secondary dataset: Department for Education, Employer Skills Survey	SQW	Improved skills across FI	Impact report	3
27	Senior management have a plan/ taking action on innovation and net-zero	Consultations with participating firms; baseline and end of programme surveys	SQW	Improved skills across FI	Baseline and impact report	3
28	Senior management have the skills to deliver innovation and net-zero successfully	Consultations with participating firms; baseline and end of programme surveys	SQW	Improved skills across FI	Baseline and impact report	3
29	Employment by sector	Baseline and end of programme surveys; programme monitoring; secondary datasets: ONS Annual Business Survey, Working Future (Department for Education), Business Register and Employment Survey (ONS)	UKRI, SQW	Improved business performance/growth	Baseline and impact report	1, 1c
30	Value of turnover (£)	Baseline and end of programme surveys; programme monitoring; secondary datasets (from FAME database if UKRI can provide access): ONS Annual Business Survey	UKRI, SQW	Improved business performance/growth	Baseline and impact report	1, 1c
31	Gross operating profit (£)	Baseline and end of programme surveys; programme monitoring	UKRI, SQW	Improved business performance/growth	Baseline and impact report	1, 1c

#	Indicator	Source	Responsibility	Outcome/ impact as per TFI programme logic model	Reported	Research Question
32	Gross operating surplus (GVA minus employment costs) (£)	Secondary dataset: ONS Annual Business Survey	SQW	Improved business performance/growth	Baseline and impact report	1, 1c
33	Share of exports in total turnover (%)	Baseline and end of programme surveys; programme monitoring (not asked yet as not relevant); secondary datasets: Eurostat Comext	UKRI, SQW	Improved business performance/growth	Baseline and impact report	1, 1c
34	Export market share (UK as a share of global exports)	secondary datasets: calculated from Eurostat Comext, UN Comtrade and Annual Business Survey (ONS)	UKRI, SQW	Improved business performance/growth	Baseline and impact report	1, 1c

Source: SQW TFI ISCF evaluation framework report

Annex E: Definitions and sources for data

Indicator	Definition	Source
Turnover	Turnover is defined as the total value of sales. This is calculated by adding together the values of: sales of goods produced goods purchased and resold without further processing work done and industrial services rendered non-industrial services rendered	ONS Annual Business Survey
Gross Value Added	Turnover generated by the business, industry or sector less their intermediate consumption of goods and services used up in order to produce their output, labour costs (for example, wages and salaries) and an operating surplus (or loss).	ONS Annual Business Survey
Gross Operating Surplus	Gross Value Added minus employment costs.	ONS Annual Business Survey and CE calculations
Employment	Average employment over the year.	ONS Annual Business Survey
Labour productivity	Units of GVA per worker.	Annual Business Survey and CE calculations
R&D expenditure	R&D expenditure in £ millions, funded by either the UK government, overseas entities (e.g. European Commission), other UK businesses, own funds, non-profit organisations, higher education establishment, international organisations.	ONS Business Enterprises Research and Development, 2019
Investment	Sum of new building work, acquisitions less disposals of land and existing buildings, vehicles and plant and machinery.	ONS Annual Business Survey
Foreign Direct Investment	Foreign direct investment (FDI) is cross-border investment made with the objective of establishing a lasting interest in the host economy. FDI is also defined by control relationships, where the direct investor (parent company) controls at least 10% of the voting power (ordinary shares) of the direct investment enterprise.	ONS Foreign direct investment (FDI) involving UK companies, 2019
Energy use	UK energy use by industry, source and fuel.	ONS Energy use by industry, source and fuel, 1990 to 2018
Emissions intensity	Emissions of greenhouse gases under the Kyoto protocol per unit of GVA.	ONS Annual Business Survey, ONS Environmental Accounts (Greenhouse gas emission in the United Kingdom 1990 to 2018).

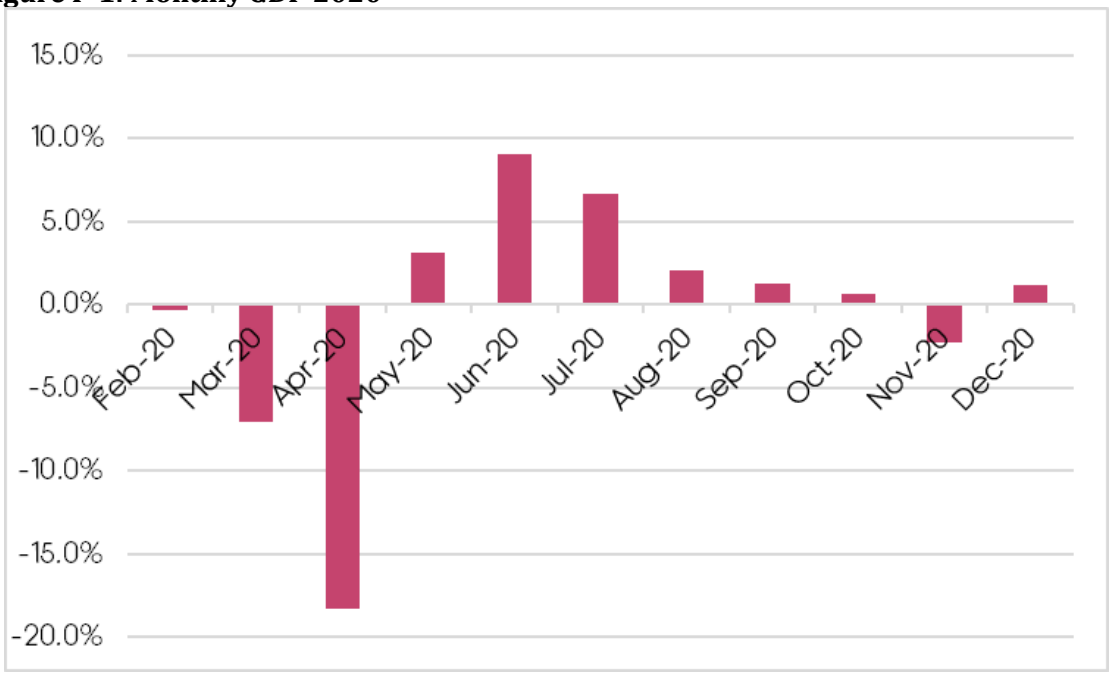
Indicator	Definition	Source
Exports	Value of goods exported.	Eurostat Comext
Imports	Value of good imported.	Eurostat Comext
Consumption of energy products	Consumption of different kinds of fuels.	Eurostat Structural Business Statistics
Employment costs	Sum of wages, salaries and social security costs borne by the employer.	Eurostat Structural Business Statistics

Annex F: Covid-19 assumptions for economic projections

F.1 This annex provides further detail on the assumptions around the impact of Covid-19 that were incorporated into the March 2021 update of Cambridge Econometrics' macro-econometric UK forecasting model, MDM.

F.2 As a result of the COVID-19 pandemic, the UK government introduced public health measures in 2020 to contain the outbreak and bring it under control. The impact of these measures and the virus was a sudden and sharp reduction in economic activity in nearly all sectors in 2020Q2 (19% reduction in GDP 2020Q2). Measures were relaxed in the summer months allowing a partial recovery before further tightening of measures (Lockdown 2.0) in November. These developments are reflected in the 2020 monthly GDP profile, as shown in Figure F-1.

Figure F-1: Monthly GDP 2020



Source: ONS (Gross Domestic Product Monthly Estimates)

F.3 In 2021Q1, in response to new more virulent strands of COVID-19, a third wave of lockdown measures were implemented, and are expected to dampen economic activity. Based on mobility indicators, it is anticipated that the third lockdown was tighter than the second but looser than the first.

F.4 It is assumed that lockdown and social distancing measures will follow the Government's envisaged 'road map', with lockdown formally ending in late-March, social distancing to progressively ease over spring and the domestic economy to open fully by mid/late summer (with all UK adults expected to be offered a dose of the COVID vaccine by this time). The

assumed 'post-lockdown' pick-up in activity will mean that the GDP is assumed to increase in 2021, thought to a lesser extent than previously forecast due to the weak start to the year.

F.5 Despite the assumed opening of the UK economy in 2021H2, persistent economic scarring and a muted economic recovery in 2021/2022 is expected. This comes as a result of rising unemployment, business closures, weak capital accumulation and permanent productivity impacts of the pandemic. Moreover, UK trade prospects remain very weak due to slow global economic growth (exacerbated/perpetuated by inequalities in the global allocation of the vaccine) and Brexit trade disruptions (see later section). Given this, the central assumption of this forecast is a 3.6% increase in GDP in 2021 and a 2.8% increase in GDP in 2022.

F.6 The post-pandemic economic recovery will depend on the responses of households, businesses and government.

- Households – Both upside and downside uncertainties are present, and the recovery experience of households is expected to be heterogenous. High levels of household saving has been recorded during the pandemic and this could help fuel economic recovery. Simultaneously, considerable job losses have also been experienced (especially among 16-24-year-olds) and pay growth is expected to be sluggish, in line with scarred productivity. Household spending is assumed to recover partially in the short term, but experience permanent impacts from the pandemic.

- Businesses – Solvency issues are expected to weigh down on business investment in the near/medium term, offset partially by government support. Consequently, the forecast assumes 1.7% growth in (total) GFCF in 2021, picking up to 3.1% in 2022.

- Government and Bank of England – The UK government and Bank of England responded in several ways to support and prop up the economy and prevent job-losses / business insolvency. Many of these schemes are expected to be phased out according to the Spring Budget 2021 (stamp duty holiday will be phased out from June, COVID job support programmes and self-employment income support will be phased out from September 2021), to be replaced by business 'Restart Grants' and 'Recovery Loans'. The forecast assumes that UK fiscal and monetary remains loose in the medium term as the economy recovers gradually. UK government is expected to tolerate higher-than-normal debt levels in the medium term, reducing the need for a budget surplus in the immediate outlook.

F.7 Government consumption in 2020 has been revised downwards considerably from the previous forecast. This is due to two main considerations: firstly, a large share of government spending during the pandemic was classified as a transfer (e.g. business subsidies) rather than government consumption; secondly, the effect of closures to public sector activity (e.g. elective medical procedures, dentistry, schools) have weighed down government consumption.

F.8 The medium-term prospects of employment recovery is expected to depend heavily on the timing, intensity and persistence of government job support measures beyond the retention

scheme. Previous recessions indicate that job losses tend to be lagged and therefore, we expect the damaging effects of COVID-19 on employment to persist, resulting in stagnating employment levels in 2021 and 2022.

Annex G: Secondary data analysis by sector

Paper and pulp

	2014	2015	2016	2017	2018	2019
GVA (£2018 millions)	4,071	4,087	3,419	3,279	3,372	3,367
Turnover (£2018 millions)	11,929	12,274	12,067	12,329	12,187	11,865
Gross operating surplus (£2018 millions)	2,092	2,109	1,489	1,304	1,422	1,469
Employment (000s)	57	56	56	55	62	60
Labour productivity (£2018 thousands of GVA per worker)	71	73	61	60	54	56
Investment (£2018 millions)	446	566	531	454	431	429
Emissions intensity (Thousand tonnes of carbon dioxide equivalent per £1m of GVA)	0.83	0.63	0.63	0.66	0.63	0.57
Exports (£2018m)	2,397	2,220	2,580	2,523	2,468	2,370
Imports (£2018m)	6,693	6,525	7,132	6,775	6,901	6,690

Note: data for 2019 is estimated using MDM.

Source: ONS (Annual Business Survey, GHG emission in the UK), Comext and Cambridge Econometrics (MDM-E3)

Chemicals

	2014	2015	2016	2017	2018	2019
GVA (£2018 millions)	4,992	4,413	4,633	5,309	5,806	5,765
Turnover (£2018 millions)	16,578	17,541	19,424	19,554	19,505	19,210
Gross operating surplus (£2018 millions)	2,879	2,059	2,001	3,031	3,530	3,524
Employment (000s)	46	46	46	45	48	49
Labour productivity (£2018 thousands of GVA per worker)	109	96	101	118	120	118
Investment (£2018 millions)	877	887	852	777	927	987
Emissions intensity (Thousand tonnes of carbon dioxide equivalent per £1m of GVA)	2.15	2.29	2.22	2.25	1.87	1.80
Exports (£2018m)	14,941	17,295	17,150	16,927	17,178	17,229
Imports (£2018m)	16,124	15,666	16,894	18,657	19,307	19,017

Note: data for 2019 is estimated using MDM.

Source: ONS (Annual Business Survey, GHG emission in the UK), Comext and Cambridge Econometrics (MDM-E3)

Glass

	2014	2015	2016	2017	2018	2019
GVA (£2018 millions)	825	1,029	1,148	1,231	1,137	1,089
Turnover (£2018 millions)	3,367	3,414	3,311	3,469	3,352	3,219
Gross operating surplus (£2018 millions)	143	351	484	534	510	487
Employment (000s)	20	18	19	22	21	22
Labour productivity (£2018 thousands of GVA per worker)	41	57	60	56	54	50
Investment (£2018 millions)	169	169	128	130	132	146
Emissions intensity (Thousand tonnes of carbon dioxide equivalent per £1m of GVA)34	1.86	1.64	1.61	1.45	1.46	1.39
Exports (£2018m)	585	600	792	793	795	810
Imports (£2018m)	1,105	1,154	1,506	1,550	1,419	1,461

Note: data for 2019 is estimated using MDM.

Source: ONS (Annual Business Survey, GHG emission in the UK), Comext and Cambridge Econometrics (MDM-E3)

Ceramics

	2014	2015	2016	2017	2018	2019
GVA (£2018 millions)	660	890	919	1,013	1,042	974
Turnover (£2018 millions)	1,592	1,900	1,820	1,969	2,058	1,936
Gross operating surplus (£2018 millions)	253	396	441	515	545	506
Employment (000s)	14	14	14	16	17	17
Labour productivity (£2018 thousands of GVA per worker)	46	62	64	62	62	56
Investment (£2018 millions)	61	122	64	38	75	85
Emissions intensity (Thousand tonnes of carbon dioxide equivalent per £1m of GVA)34	1.86	1.64	1.61	1.45	1.46	1.39
Exports (£2018m)	305	301	368	372	375	363
Imports (£2018m)	973	1,059	1,290	1,213	1,163	1,289

Note: data for 2019 is estimated using MDM.

Source: ONS (Annual Business Survey, GHG emission in the UK), Comext and Cambridge Econometrics (MDM-E3)

[34] Emission intensity is shown for glass and ceramics combined.

Cement

	2014	2015	2016	2017	2018	2019
GVA (£2018 millions)	390	1,378	1,365	1,162	1,246	1,165
Turnover (£2018 millions)	2,330	4,803	4,465	4,269	4,317	4,060
Gross operating surplus (£2018 millions)	89	901	857	665	762	709
Employment (000s)	18	15	15	17	17	18
Labour productivity (£2018 thousands of GVA per worker)	22	89	89	68	73	66
Investment (£2018 millions)	130	165	150	160	127	144
Emissions intensity (Thousand tonnes of carbon dioxide equivalent per £1m of GVA)34	29.16	7.96	8.09	9.05	7.97	7.45
Exports (£2018m)	78	83	111	117	116	115
Imports (£2018m)	237	254	324	338	351	394

Note: data for 2019 is estimated using MDM.

Source: ONS (Annual Business Survey, GHG emission in the UK), Comext and Cambridge Econometrics (MDM-E3)

Metals

	2014	2015	2016	2017	2018	2019
GVA (£2018 millions)	2,041	1,971	1,352	1,821	1,467	1,385
Turnover (£2018 millions)	12,005	11,222	10,814	10,839	10,731	10,267
Gross operating surplus (£2018 millions)	789	646	-681	517	234	205
Employment (000s)	31	30	30	33	36	36
Labour productivity (£2018 thousands of GVA per worker)	65	66	45	55	41	39
Investment (£2018 millions)	209	268	335	406	225	226
Emissions intensity (Thousand tonnes of carbon dioxide equivalent per £1m of GVA)34	12.70	10.00	9.37	7.19	8.28	8.25
Exports (£2018m)	36,299	39,502	23,314	26,843	36,503	30,892
Imports (£2018m)	26,501	25,344	61,398	44,634	34,295	70,872

Note: data for 2019 is estimated using MDM.

Source: ONS (Annual Business Survey, GHG emission in the UK), Comext and Cambridge Econometrics (MDM-E3)

SQW

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About us

SQW Group

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