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Transforming Foundation Industries – Industrial Strategy Challenge Fund Evaluation

Process and Progress Report

SQW

Contents

Contact:
Sarah Brown
Tel: 0161 475 2102
email: sbrown@sqw.co.uk

Approved by:
Osman Anwar
Director
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1. Introduction

1.1 The Transforming Foundation Industries (TFI) Industrial Strategy Challenge Fund (ISCF) programme includes six sectors: cement, ceramics, chemicals, glass, metals and paper. 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 The overarching aim of the programme is:

By 2024, transform the UK's Foundation Industries so that they are internationally competitive in manufacturing products vital for the economy in an environmentally sustainable way.[1]

1.3 This is underpinned by five key programme objectives:

1. Accelerate innovation and new collaborations across the sectors via delivery of Pilot Scale facilities and Collaborative Research and Development (CR&D)

2. Increase multi/inter-disciplinary research and innovation across the sectors through supporting development of the foundation industries as a sector

3. Develop closer academic and industry links through programmes dedicated to technology transfer

4. Accelerate growth of new technology and fast-growing businesses across the value chain through co-investment with Private Equity

5. Increase Foreign Direct Investment (FDI) in the UK and business investment in R&D via CR&D and pilot scale facilities.

1.4 The programme is comprised of 5 workstreams:

[1] UKRI, (30 April 2019) ISCF Transforming Foundation Industries Business Case.

Table 1-1: TFI Challenge workstreams

Workstream	Key activities
W1: Establishment of the foundation industries pilot scale facility (£15m)	Construction of a pilot facility (incl. equipment) for the glass sector in St. Helens
W2: CR&D and phased demonstrators to support industry (£31m)	Series of industry led CR&D competitions
W3: New approaches to sustainable foundation industries – connecting universities and firms (£5m)	Competition organised to facilitate knowledge transfer from academics to companies, with companies providing matched funding for projects
W4: Establishing the foundation industries as a sector (£5m)	Sector strategy Part of Network+ • coordination and development of a network across the foundation industries • competition for small projects • production of research papers ESRC activity TFI sector skills report; training and skills development
W5: Investor Partnership (£10m)	Selection of investors and funding competition for companies

Source: SQW

1.5 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 (completed)
- Phase 3 – interim evaluation (current report on process and progress), January 2022 to October 2022
- Phase 4 – final evaluation (impact), January 2023 to March 2024.

1.6 The purpose of this process and progress report is to:

- assess how the design and delivery of the programme have contributed to achieving objectives to date and are facilitating the progress towards realising outcomes and impacts as identified in the programme's theory of change
- identify and consider wider contextual factors that may influence how effectively activities are being delivered, for example new environmental standards, wider technological and policy developments, and changes in international competitiveness
- to gather learning that can be used by the programme to refine its activities during the remaining timeframe, for instance, identification of any barriers or facilitators to impact and how they may be managed or overcome.

1.7 The report has gathered evidence using the following research methods:

Table 1-2: Research informing process and progress report

Method	Research undertaken
Tel. interviews with the TFI delivery team	10
Tel. interviews with companies	20
Tel. interviews with glass facility staff and users	3
Tel. interviews with academic researchers	5
Tel. interviews with investors	5
Tel. interviews with wider stakeholders	13
Inputs from sector experts	3 sector experts (part of the evaluation team) provided information on contextual changes
Analysis of applicant data, monitoring data and programme documents	Quarterly reporting on Glass Futures (to June 2022), the Transfire Hub (to July 2022), and Network+ (to June 2022) Data extract for CR&D competitions and the IVP projects containing 86 projects, monitoring officer scores for CR&D projects to June 2022, responses to the inflight benefits survey distributed by TFI to September 2022 Programme Board updates to June 2022.

Source: SQW

1.8 The evidence was triangulated and analysed against the TFI programme logic model. Emerging findings were tested with the TFI delivery team in July 2022.

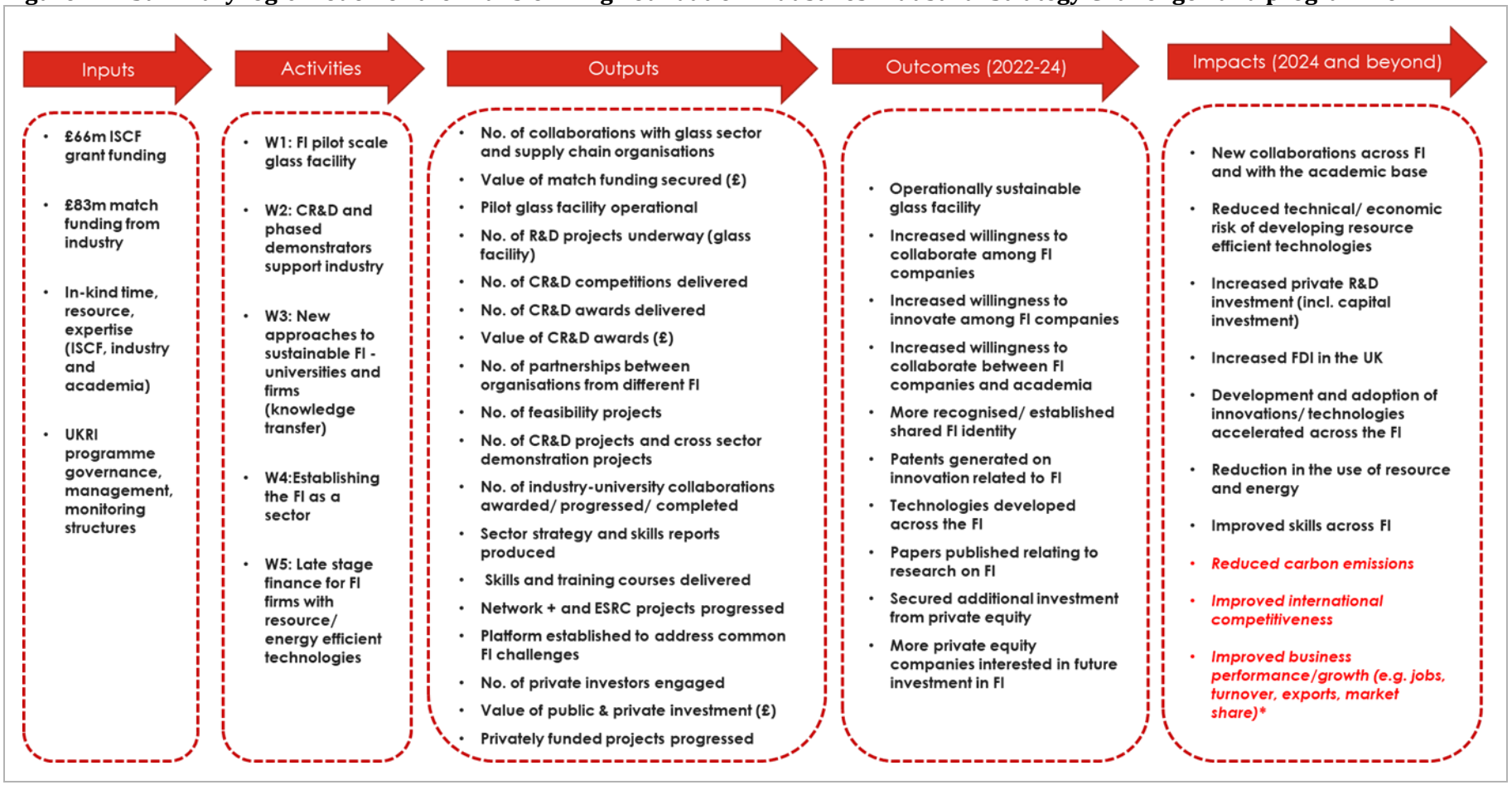
Report structure

1.9 The report is structured as follows:

- Section 2 provides contextual updates
- Section 3 presents process evaluation findings
- Section 4 assesses progress towards outcomes and impacts
- Section 5 outlines emerging conclusions and next steps.

1.10 The following annexes are included as part of the report: progress against the objectives; progress against output metrics; and progress against outcome and impact metrics.

Figure 1-1: Summary logic model for the Transforming Foundation Industries Industrial Strategy Challenge Fund programme



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

2. Contextual updates

2.1 This section presents contextual updates relevant to the Foundation Industries as a sector and for the six sub-sectors.

Cross-cutting contextual changes

2.2 We identify five key issues – market and policy related – currently affecting all six of the FI sub-sectors. These include: rising energy costs; disruption in supply chains; access to relevant skills; legacy of Covid-19 impacts on working culture/ patterns; and policy imbalance between energy reduction against resource reduction. We discuss these further below.

2.3 First, most consultees report the increased cost of energy and the associated cost of doing business for all FI as the greatest challenge for all FIs. The high energy-intensive nature of the FI means they are particularly vulnerable to energy price rises, as energy costs comprise a greater proportion of product costs compared to other industries. However, for British FI, the price inflation is compounded by the loss of international competitiveness: while energy prices have increased globally, prices have not risen as much across Europe as they have in the UK. The situation is also exacerbated by continuing insecurity and volatility in energy supply and cost. The political instability generated by the conflict in Ukraine, the related uncertainty about sources of gas supply, and strong competition for available supply, means businesses are struggling to plan for future sources of energy and manage costs.

2.4 The developing energy crisis is happening against the backdrop of the UK Government's commitment to net-zero (carbon-neutral) by 2050 and growing consumer focus on sustainability. In this context, one of the wider stakeholders interviewed identified that the pressure to deliver carbon reductions is becoming more prominent and that*, "there is a recognition that some of the biggest changes [to reduce CO_2) can come through addressing concerns in the Foundation Industries"*.

2.5 Second, there is ongoing disruption within supply chains for all FI. These are a result of international factors (e.g. Brexit, Ukraine) which has led to delays at borders, the introduction of new tariffs or administrative costs, and uncertainty about how to respond to new regulations. Supply chain disruption entails a range of impacts on businesses such as delays to the receipt of components but which all ultimately increase costs. The potential advantage of supply chain disruption, as identified by one stakeholder, is that it increases demand for UK FI production as a more reliable source of FI goods.

2.6 Third, businesses are continuing to struggle to access the skills they need. Brexit has affected the supply of skills as well as goods: some skilled workers have left the UK and it is harder to attract skilled Europeans. This has increased the costs of hiring skilled people and reduced their availability for FI businesses. The exit from EU funding schemes such as Horizon Europe is one example of a route that used to bring highly skilled workers to the UK which is now

closed. In the context of an ageing workforce, with significant and growing skills gaps, the skills shortages in the sector are becoming more acute, even as the FI are struggling to attract more younger, diverse staff.

2.7 Fourth, the legacy of Covid-19 impacts on working culture and work patterns is continuing to be felt: greater home-working (among certain staff) has reduced opportunities for people to network at face-to-face events and to collaborate with colleagues and peers.

2.8 Against the backdrop of these challenges, there is a continued imbalance in terms of the policy focus on energy reduction against resource reduction. The legal commitment to the UK being net-zero (carbon-neutral) by 2050 overshadows other routes to increased sustainability: for the FI, resource reduction is likely to play an important role (alongside energy reduction) in increasing the environmental sustainability of these industries. Yet the methodologies to effectively assess environmental impact, particularly in terms of resource reduction, and thus support the introduction of resource reduction measures, are under-developed.

Contextual changes by sub-sector

2.9 Beyond the general economic and political factors affecting the FI, there are particular ways in which these issues affect each of the six sub-sectors, as outlined in Table 2-1.

Table 2-1: Contextual issues affecting the FI sub-sectors

Sector	Contextual issues
Cement	• Cement has benefited from rising demand for the product from the construction industry as Covid-related work restrictions are lifted. However, the growing profile of net-zero post-COP 26 is increasing the pressure to decarbonise one of the most carbon-intensive industries.
Ceramics	• The high temperatures required by ceramic manufacturing processes entail an extremely heavy dependence on gas for firing so the sector is suffering more than most other sectors from the increasing energy prices. The challenge is that current electricity infrastructure in terms of both generation and distribution is not sufficient for the sector to rapidly transition at scale to electric firing so there is a requirement for interim fuel solutions as gas is phased out. The sector will also struggle to adapt existing manufacturing kit to use other fuel sources. For instance, existing kilns designed to run on gas typically have a 25 year lifespan. • There are a number of technical challenges the ceramics sector faces in becoming more sustainable, for example identifying lower carbon fuels/heating methods (e.g. faster process cycles and/or lower peak process temperatures).
Chemicals	• Increasing fossil fuel prices have a dual impact on the chemicals sub-sectors as they are both an energy source (as with the other sub-sectors) and a feedstock. Therefore there is a dual technical challenge in decarbonising both energy sources and feedstocks. Chemicals is also heavily dependent on its research and science base in terms of remaining internationally competitive which makes it particularly vulnerable to the

Sector	Contextual issues
	effects of Brexit on access to skills and funding programmes such as Horizon Europe.
Glass	• Like ceramics, the high temperatures required by glass manufacturing processes entail an extremely heavy dependence on gas for firing furnaces. Energy constitutes 20-30% of glass manufacturing costs so the rising energy prices are having a major effect on competitiveness. As with ceramics, the current electricity infrastructure (generation and distribution) is not geared up to manage mass transition from gas-dependent glass production. • The sector is experiencing changing demand from the automotive industry, a significant consumer of glass. Shortages of semi-conductors are reducing car production which is in turn reducing demand for glass. At the same time, improving efficiencies in manufacturing of electronic capacitors (that are cheaper, lighter and more environmentally friendly) for electric vehicles is increasing demand for glass. There is also increasing consumer demand for recycled glass and from the steel sector. • The challenge for the UK glass industry is that 8 of 10 large glass companies, responsible for 95% of UK glass production, are foreign owned, meaning investment in UK based innovation needs to be made attractive.
Metals	• The rise in construction in the post-Covid period is leading to increased demand for steel (as well as cement). However, there is concern that steel tariffs may invite retaliation from other countries, affecting competitiveness of UK steel. • Research support for the metals sector is already weak and perceived to be vulnerable to skills shortages caused by Brexit and reduced government funding. This is in a context of the need for research to meet increased demand for more sustainable processes.
Paper	• Paper has significant potential as a sustainable product as it has no intrinsic reliance on fossil fuels either as a feedstock or energy source and has carbon capture potential. The potential for growth is already supported by increased demand for paper over plastics for some applications/products. • The growth in e-commerce and the implications of collection (millions of households compared to thousands of retailers) alongside new rules on local authority wastepaper collection poses a challenge to maximising recycling. Moreover, planning rules make it challenging to develop manufacturing sites, if there were scope to replace the half of UK paper consumption that is imported. • As with the glass industry, most (9/10) large paper companies are foreign-owned, meaning investment in UK-based innovation (at least industrial-focused process improvement) needs to be made attractive.

Source: SQW

Implications for FI and evaluation

2.10 Ultimately, macroeconomic changes and political uncertainty, both national and international, are putting pressures on FI, increasing the cost of doing business, reducing their competitiveness and challenging the imperative to increase environmental sustainability.

One serious consequence of these pressures is that there may be less resource and capacity for investment across the sectors, meaning less resource for innovation and collaboration, particularly new, cross-sector collaborations. The TFI delivery team reported that during the recent 'Demonstrator' competition, several organisations pulled out because rising energy prices had squeezed their budgets. However, cross-sector collaborations offer some important opportunities, for example in terms of learning about the availability of waste streams from one industry which could be used by others, the way the steel sector uses recycled glass. The effects of these contextual changes depend on whether firms demote innovation as a priority, seeing it as a cost and threat to business survival, or value it as a potential route out of crisis and towards improved competitiveness.

2.11 The TFI programme offers the opportunity to support these sub-sectors to innovate during a particularly challenging period. Uniquely, it provides a change for the distinct sub-sectors of the FI to collaborate to meet common challenges and maximise potential gains from collaboration. It will be necessary for the programme to make a clear case about the value to be gained from innovation during straitened times. There may also be a requirement to support any short-term alleviation of energy issues to ensure companies are in a position to continue innovation initiatives.

2.12 The evaluation moves into the final phase in 2023, in which a final assessment of the impact of the programme will be completed. During this phase, the evaluation will need to respond to changing circumstances and ensure the assessment takes into account the role played by external circumstances in order to deliver a fair and balanced judgement.

3. Process evaluation findings

Summary

- The TFI programme is making good progress against all of its five objectives. Progress on collaboration and the development of a shared FI identity is particularly encouraging.
- Progress is largely attributable to involving industry in the programme design, a workstream focused on engaging the sub-sectors and bringing them together, and effective delivery of the programme.
- The main constraints on delivery have been capacity of the TFI team and external factors such as recruitment challenges and availability of sub-contractors.
- There is scope for greater cross-workstream sharing of learning and engagement to maximise synergies within the programme.
- Collection of contact details and permissions for programme participants will be critical to ensuring the evaluation is able to capture outcome and impact data to supplement data from the monitoring system.

3.1 This section addresses the evaluation's process research questions on the design and delivery of the programme. This includes the synergies of the different programme strands, alignment to industry needs, and how collaboration between sectors, and industry and academia has been developed.

RQ1. Has the intended design and delivery of the programme enabled the programme to achieve its objectives?

3.2 The TFI programme is making good progress against nearly all of its five key objectives: to accelerate innovation and new collaborations, increase multi/interdisciplinary research, develop closer academic and industry links, and attract private investment into FI businesses (Annex A provides details of progress against all objectives).[2] The key programme design features that have enabled this include the involvement of industry in co-developing the Challenge, and the FI strategy for creating a shared identity across the FI sub-sectors. The programme has generally been delivered in an effective and efficient manner to date. The TFI

[2] TFI programme objective 5 on 'increasing FDI in the UK' is longer-term and will as part of the impact assessment in 2023/24.

delivery team (senior leadership and supporting staff) has provided the leadership, direction and support. Most consultees reported that the management, governance and monitoring processes were generally appropriate and proportionate. A minority of consultees questioned the balance between the sectors within the programme, whether there could have been more promotion, and the capacity of the TFI team to deliver activities (i.e. need for more staff/ resource). Nevertheless, the general consensus was that the programme has been well delivered and pragmatic given the difficult market context.

3.3 We provide further detail the key features of programme design that have contributed to objectives.

3.4 **Involvement of industry and other relevant stakeholders such as academics, industry bodies, and other UKRI programmes/bodies such as Made Smarter Innovation and KTN**. This helped ensure the programme took account of (some) industry priorities and preferences. The programme has been widely welcomed: there is a recognition that investment in innovation in the sector, particularly on decarbonisation and environmental sustainability has been lower than required, both on the part of the public and private sector, so the programme represents an important catalyst to ratcheting up innovation.

3.5 **The multiple 'doors' to entry, namely a range of activities of differing scope and scale, through which businesses can engage with the programme**. This also means that the programme has multiple avenues to reach its objectives, taking account of current and future demand, and building in some resilience. For example, companies can progress technological innovations through a CR&D funded project, by engaging with academics in Transfire (the Hub), or (if appropriate), via support from Glass Futures. A range of wider stakeholders offered positive comments about the supplementation of the CR&D competitions, seen as a standard route to encouraging innovation, with other opportunities such as the Hub and Network+.

3.6 **The sector strategy activities in workstream 4 (WS4) that underpin the innovation-focused workstreams** (Glass Futures, CR&D, Investor Partnership programme and, to some extent, Transfire). The sector strategy activities are focused on supporting the development of the FI as a sector, such that companies self-identify as part of FI, as a precursor to collaboration and shared problem-solving. In retrospect, the value of WS4 could have been maximised by beginning with some of the networking activities to generate more collaborations and better quality applications for the CR&D competitions.

3.7 The management, governance and monitoring structures appear to be working effectively. This is discussed in more detail below (3.14).

3.8 **A minority of interviewees challenged some aspects of the design**. **The balance between the sectors caused some contention.** While one stakeholder stated that the Glass Futures workstream was *"was clearly industry led and meeting an unmet market need"*, another was of the view that the Challenge had over-invested in the glass sector. There was also some debate about the inclusion of chemicals: a small number of stakeholders thought it was challenging

to include such a diverse sector in the programme. Another stakeholder queried the delivery model for Glass Futures: as an independent not-for-profit company, with a focus on ensuring its short-medium term financial security, it was perceived that the focus was on intermediate priorities such as bio-fuels rather than the longer-term and ultimately more important issue of electric-melting. This interviewee was of the view that this was a missed opportunity to take a more radical approach to decarbonisation of the glass sector.

3.9 In terms of the CR&D competitions, there was mixed feedback regarding whether the scope was broad enough to allow for a range of technologies to be pursued or whether the competitions were too tightly defined, excluding topics that might have been of interest to industry. One stakeholder gave an example related to ceramics: *"carbon capture and use was in scope but carbon capture and storage wasn't, and neither was fuel switching."* There was, however, agreement on the part of a small number of stakeholders that there should be simplification of the funding calls, both within TFI and across government more generally, on the basis that fewer calls that were increased in length and value would be easier to promote and easier for potential applicants to access. A further suggestion from a couple of stakeholders consulted was that the calls should have been aligned more clearly to sector strategies. The competition application processes were generally acknowledged to be straightforward but a small number of consultees reported that some companies are disincentivised by the administration, especially SMEs, for whom the opportunity cost of applying is higher than for larger companies.

3.10 The following key features of programme delivery have contributed to objectives.

3.11 The application process for CR&D projects was relatively straightforward; administration support and monitoring provided by Innovate UK was broadly seen as positive, helping projects to keep on track and organised (with only a minority perceiving reporting requirements as onerous); and the programme has been flexed at times to respond to circumstances, for instance adapting the CR&D calls in response to the ESRC survey, introducing the Covid Response CR&D call and allowing projects to reallocate underspend (although in a minority of cases financial change requests were perceived as slow and inflexible). The Challenge is perceived as being pragmatic, in the view of one wider stakeholder: *"the team is prepared to try different things and if something isn't working, they are prepared to try something new".* This generally positive perception of the quality of delivery was echoed by participating businesses, academics and investors.

3.12 **The main issue related to delivery was whether the Challenge could have been promoted more effectively**. *"I get the impression that if you are part of existing UKRI/KTN/IUK networks you are likely to be kept up to date of the TFI…. On the comms side there is maybe something missing on the bigger picture side of it."* (Wider stakeholder.) More information about the overall aims, their relevance to individual sectors, the potential for synergies between firms, and links to policymakers, would all have been welcomed. There was a specific suggestion from one stakeholder that TFI could learn from the BEIS Industrial

Energy Transformation Fund approach to engaging with potential applicants, with a *"marketplace and one-to-one conversations"* to provide information about competitions.

3.13 **The main constraints on delivery were seen to be the capacity of the TFI team, and external constraints** including: access to materials; availability of sub-contractors; challenges to recruitment of academics; long-term structural limitations in the UK research landscape (for example the absence of a paper science undergraduate degree course); and Covid restrictions on TFI and industrial capacity (for example limiting plans/opportunities for collaborative working).

Management and governance

3.14 Feedback on management, governance and monitoring of the programme is broadly positive across all consultee groups, with guidance, flexibility and additional information highlighted as valuable. TFI team capacity and a reliance on evaluation evidence for quantitative measurement of outcomes were the main issues of concern.

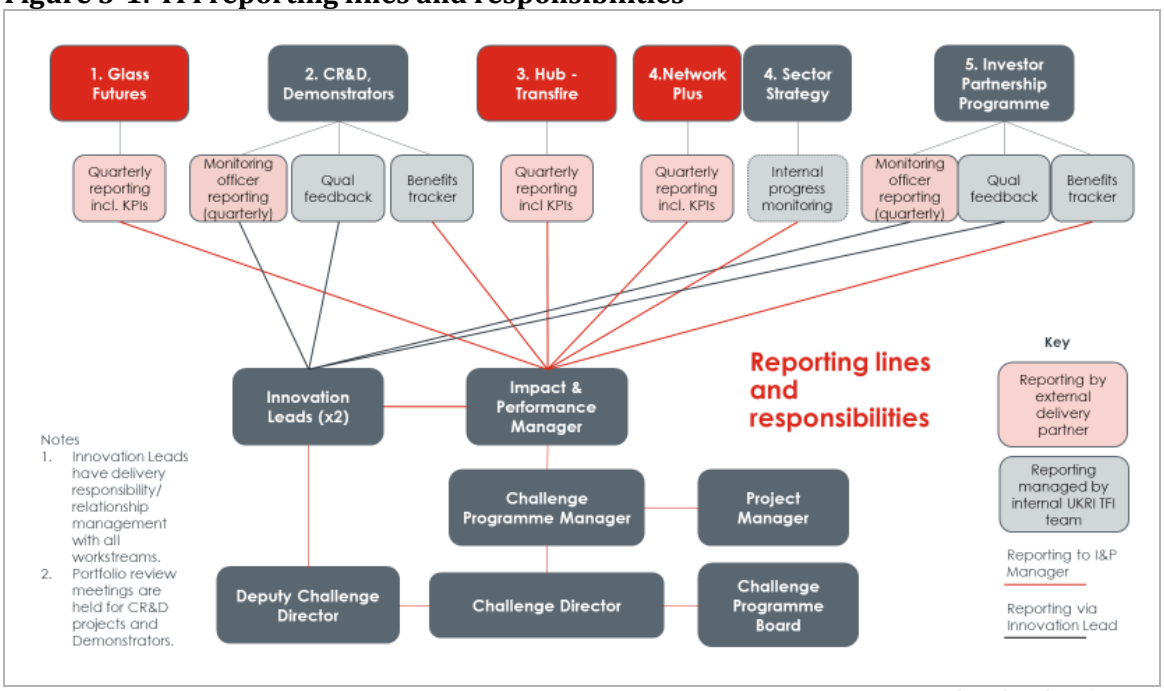
3.15 Guidance on UKRI systems and processes, flexibility and provision of additional information were cited by interviewees as the most valuable aspects of support. One interviewee commented:

"The management team for TFI is clearly very strong, with links to industry and the ability to work with them. If TFI doesn't achieve the outcomes, it won't be because of the management team. They are clearly capable."
Wider stakeholder

3.16 Figure 3-1 depicts the management and monitoring structure and process of the Challenge. The Challenge Director heads a team comprising the Deputy Challenge Director, two Innovation Leads, a Programme Manager, a Project Manager and an Impact and Performance Manager. There is currently a vacancy for the Programme Manager. The TFI team directly delivers on three workstreams: CR&D, the Investor Partnership programme (IVP), and the sector strategy element of WS4. Glass Futures is delivered by an independent not-for-profit company and the Transfire Hub is delivered by a consortium of twelve universities and other partners. Network+ is managed by EPSRC and delivered by a consortium of four universities.

3.17 There is an issue with team capacity given the current Programme Manager vacancy but capacity was an issue from relatively early on. The sector strategy element of WS4 is considered to be under-staffed, potentially by 0.5 FTE. With additional resource, this workstream could have made more progress sooner. WS4 is further hampered by the lack of an EPSRC lead for two of the academic projects (totalling £7.7m). A small number of consultees expressed concern over whether the Challenge has an over-complex management structure.

Figure 3-1: TFI reporting lines and responsibilities



Source: SQW based on data from TFI

3.18 A small number of consultees also sounded a note of caution about the level of reporting requirements although this was not a concern raised by most businesses we interviewed. The workstreams delivered by external bodies report directly into the Impact and Engagement Manager. The workstreams delivered by the team have internal reporting: qualitative feedback goes initially to the innovation lead; responses to the benefits tracker survey go to the Impact and Engagement office. Workstreams that provide competitive funding to businesses have reporting by monitoring officers, who are independent of UKRI and report on the progress of funded projects against a set framework. This use of monitoring officers is standard UKRI practice.

3.19 The monitoring system is still relatively untested as many of the workstreams and interventions are in a relatively early stage of delivery with outputs only recently beginning to be reported and outcomes and impacts still anticipated further down the line. To date, the reporting system has provided useful information on progress against milestones and early outputs.

3.20 There is less information available about outcomes and impacts because the majority of activities will not yet have led to these. However, it may be challenging in future to quantify some of the key outcomes of impacts arising from the programme. This is partly because of the diverse nature of funded activities and the challenge of comparing across different sectors and technologies: for example, it is not straightforward to compare reductions in the weight of raw materials for different processes. It is also the case that standardised processes for measuring different metrics such as reductions in material used do not exist.

3.21 The current inflight benefits survey used by the programme to capture outcomes and impacts from funded CR&D projects collects some useful information on whether projects are experiencing a range of outcomes, including expenditure on R&D, FDI, private equity, reductions in CO2 emissions, energy use or waste/resource, new and safeguarded jobs, new skills, IP licenses, research papers, new cross-sector collaborations and new commercialised products and/or services. Yet for some of these metrics there will only be qualitative information regarding the nature of the outcome rather than a response that can be aggregated. Reporting from other workstreams is detailed and informative but generally in the form of lengthy narrative which makes it challenging to rapidly identify where progress is or is not happening.

3.22 Aside from the Programme Board reports, which are largely in narrative form, there is no central view of progress by workstream and at an overall Challenge level. The absence of transparent, streamlined monitoring of outcomes and impacts by the programme means evaluation evidence, for example that gathered through a survey of participating businesses, will be critical. It will therefore be essential to ensure contact details and permissions are properly collected from all participating businesses, particularly those involved in initiatives being delivered outside the core TFI team such as Glass Futures and Transfire. Further, to undertaking comparative analysis of unsuccessful applicants, contact details and permissions will also be required.

3.23 Among both the TFI team and the programme's stakeholders there is a recognition that impacts on business competitiveness and hence economic measures are longer-term. These are probably beyond the programme and evaluation timeframe. Thus, there is interest in gauging success via non-economic metrics, such as skills, and interim metrics such as additional private sector investment.

RQ2. Did the programme meet its target outputs efficiently and effectively?

3.24 Overall, the programme is doing well in delivering programme outputs efficiently and effectively. There is some diversity across workstreams, CR&D and IVP furthest ahead, followed by Glass Futures, Transfire and Workstream 4 (including Network+). Annex B provides details of progress against all outputs: below we focus on progress against some of the key outputs.

3.25 The CR&D and IVP workstreams are furthest ahead in terms of having set up all activities: both workstreams have awarded all funding to projects and are now monitoring progress. CR&D competitions are a standard delivery model in UKRI for cross-sector and business-academia collaboration, TRL progression and development of new technology, so good progress was anticipated. Nevertheless, the TFI team have still delivered effectively to ensure sufficient applications of sufficient quality such that all funds could be awarded. The workstream is exceeding targets in terms of value of grants awarded and number of projects progressed by this point.

3.26 The IVP route was slightly different to the standard CR&D competition in that private investors were sought as part of the project development process. This entailed additional work upfront to bring investors on board although they are still relatively standard R&D projects aiming to deliver technological innovations. IVP is performing particularly well in terms of value of private funding that has been leveraged (more than £20m against a target of £5m in the first year).

3.27 Glass Futures is making reasonable progress in terms of delivery on construction, having faced challenges during periods of Covid-related restrictions, and attracting members. However, it has only achieved £1.1m against a target of £22m. Transfire has started to make good progress in achieving collaborations and Network+ has exceeded its target on progressing early stage research projects. Both workstreams are quite far behind in terms of numbers of papers published but these are likely to be delivered nearer to the end of the projects.

RQ3. How effectively do the different strands of the programme work together and makes the programme as a whole more effective as opposed to delivering individual strands?

3.28 The programme strands complement each other and in some respects there are useful overlaps: a small number of participants are involved in multiple strands. However, the workstreams remain fairly distinct and, as such, there is scope for greater cross-workstream sharing of learning and engagement to maximise synergies within the programme.

3.29 **There are complementarities in the programme.** A number of aspects of design are intended to link the different workstreams and ensure it is a coherent whole; the five workstreams share common thematic objectives and WS4 is inherently cross-cutting as it tries to bring together representatives from across the sectors to consider common challenges and potential joint opportunities. In addition, some activities have been intentionally designed to overlap and support each other. For instance, Glass Futures Ltd is represented on the Programme Board and is involved in supporting both the Transfire Hub and the international aspects of the sector strategy work in WS4. There is also cooperation between Network+ and Hub in terms of networking and sharing expertise. Some Programme-level events that sit outside specific workstreams have led to partnerships across companies and academics. WS5 is probably the most independent workstream, with the investors and companies focused on the specific piece of work in which they have a shared interest. The fact that a small number of companies are active in multiple workstreams, for example companies participating in CR&D projects are variously involved with Glass Futures, Transfire, and sector strategy activities such as skills initiatives, shows that the activities can be complementary.

3.30 The TFI delivery team believe that the level of overlap is appropriate and avoids duplication. However, the general perception, among stakeholders, businesses and academics, of TFI is that it is a 'jigsaw', with distinct parts that fit together coherently but without much

interaction between different workstreams. This perception is supported by feedback from a range of consultees. It is important to note that, at this stage, most consultees did not see this as a weakness in the programme but it was anticipated that interactions between workstreams could grow over time, as there was potential for shared learning and valuable networking among existing programme participants. In particular, the majority of businesses consulted perceived synergies as potential rather than actual. Most are involved in single CR&D projects but are interested in opportunities beyond that.

3.31 The issue for the programme is to identify where and how cross-workstream activity and learning can be generated efficiently and to maximum effect. One point to consider is the extent to which participants in one workstream are aware of opportunities in other workstreams. Consultees reported that they were not clear on what other parts of the Challenge did and how the various elements functioned as a whole. There were two suggestions about how the Challenge could deliver additional value:

- clearer identification of shared challenges between sectors; and
- more support to interested organisations to identify potential partners.

3.32 Some of this work is underway, at least informally, but there is a lesson for future initiatives about the value of preparatory work to speed up and enhance programme delivery.

RQ4. Is the programme sufficiently aligned to industrial needs (and consumer needs if relevant)?

3.33 Feedback from consultees and monitoring evidence suggests that the programme is fairly well aligned to industrial needs. Crucially, the programme has been able to award more than the planned amount of grant funding for CR&D projects and attract a good number of members to Glass Futures. Limitations stem from the programme's five year timeframe and meeting the needs of all six sub-sectors.

3.34 The programme design process included industry to ensure its relevance to business both in terms of areas of focus and the market failures that needed to be addressed. It is therefore reassuring to have feedback that the focus on energy and resource reduction was and is relevant and timely for the FI and there are common needs, issues and potential solutions which could benefit from collaboration. As one stakeholder commented, *"the remit of the TFI is looking at where all emissions can be reduced – that whole supply chain view is something that is really novel to the TFI and good compared to where other funds are looking at one area. That cross-cutting view to look at each stage of material use, how can we improve things, is really important."*

3.35 Similarly, activities addressing market failures were reportedly appropriate and welcome, for example the lack of academic-industry collaboration as addressed by the CR&D competitions and the Transfire Hub. The programme's ability to award all CR&D funding as planned demonstrates that there was a sufficient number of quality applications to the competitions,

from which it can be inferred that these opportunities were seen as valuable for companies. The growth of membership for Glass Futures can also be interpreted as the model meeting industry needs. Feedback from businesses has indicated that they value the support for innovation as it de-risks their own investment in these projects. One interviewee observed, *"if a company is operating a single kiln on site, then there's an inherent risk to taking on a new technology because that's their only kiln."*

3.36 The main shortcoming perceived by stakeholders is the timescale of the programme: new innovations and investments in FI are typically formed and delivered over one to two decades. Although TFI has focused on major priorities for the sector, including decarbonisation, its five-year lifespan of the programme restricts the extent to which TFI can support change over a longer timeline. In practice the programme is working on a short-to-medium- term impact horizon.

3.37 There were also queries raised about the extent to which:

- funding calls could have been more closely aligned with sector strategies to ensure they were maximally relevant to the sector
- there was common ground between the six sectors. While some shared challenges were acknowledged, it was felt that two sectors in particular had less potential for collaborative research. Paper is manufactured at a lower temperature than products within the other sectors typically are. Chemicals is a more diverse sector with some very different manufacturing processes. On this basis it was suggested there could be a proportion of funding ring-fenced for each sector to address unique issues
- the programme was designed to reach new businesses rather than those already in the orbit of UKRI and its peer organisations. It was felt that the majority of participating businesses had prior awareness of Innovate UK and it was unlikely those without that awareness would hear about TFI. It was proposed that marketing could be more attuned to the needs of smaller, younger companies.

RQ5. To what extent and how has the set up and delivery of the programme encouraged the collaboration (or partnerships) of businesses and academics?

3.38 The programme has been effective at encouraging the collaboration of businesses and academics: workstreams either require collaboration as a condition of participation or bring industry and academia together through cross-discipline events. A total of 52 universities/RTOs have been involved in funded projects as part of the programme so far.

3.39 Two of the workstreams require collaboration: three of the CR&D competitions in WS2 required projects to include at least two companies and an academic partner[3]. To date, 52 universities/RTOs are involved in CR&D projects; and the Transfire projects involve collaboration between academics and businesses.

3.40 By their nature, the sector strategy activities in WS4 are cross-discipline and often bring together academics and business. Network+ is also reported to be generating new collaborations.

3.41 While monitoring data show the number of academic collaborations with business, it does not show if these interactions are between businesses that have not previously engaged with the research base. However, qualitative feedback from companies engaged in CR&D projects indicates that a significant proportion are new to research collaborations (generally this includes smaller businesses) and the experience has been a positive one that has increased their willingness to undertake further collaborations. In particular, they have valued the expertise brought by some academics and access to high quality testing and pilot facilities. Specifically, just over half (55%) of businesses interviewed in this phase reported increased willingness to collaborate with academics / research base and innovate more widely. In some cases, the innovation was not restricted to technological issues. One wider stakeholder interviewed remarked that they had *"seen examples of companies better accessing social science knowledge for example understanding trade policy or their innovation skills needs."*

3.42 Academics have also reported positive experiences from collaboration, indicating that it has broadened their perspective of who to engage with and on what topics. *"It has changed my view on the types of people in the future I could collaborate with."* [Academic participant.]

3.43 In the longer-term, the enforced collaboration of the CR&D funded projects, along with the other networking activities, has provided the foundation for new connections and partnerships. Positive experiences have yielded examples of the benefits of collaborations and encouraged businesses to seek further collaborations as a route to supporting innovation and strengthening their business.

3.44 **Different priorities and ways of working have, in a few cases, generated tension between businesses and academics**, with the former perceiving that academics can be too focused on specific research issues as opposed to commercial imperatives and sometimes cannot deliver at the pace required by industry. One consultee suggested that academics had to demonstrate the value of research collaboration to businesses so they were more accepting of practical differences. Another suggestion was that TFI could take a more active and directive role in a) identifying gaps in academic expertise and trying to bring in researchers that could extend the range of issues the programme can address and b) taking a more active

[3] Covid Recovery and Small Strand R&D 1 and 2 permitted single businesses to access grants without a collaborator.

role as broker, bringing businesses and academics with similar interests together rather than leaving them to find each other.

RQ6. To what extent and how has the set up and delivery of the programme encouraged collaboration of businesses of different sizes?

3.45 The programme has been effective in generating collaboration of businesses of different sizes and businesses from different sub-sectors: three of the CR&D competitions required collaboration as a condition of participation. Businesses were supportive of cross-sectoral collaboration but sceptical about collaboration between sectors where process similarities were less evident.

3.46 As with the research-business requirements, collaboration of different sized businesses from different sectors was built into the programme, for example via the CR&D competition requirements: the Large CR&D strand eligibility criteria stated that applicants must *"include at least two businesses of any size, from at least two foundation industry sectors".* The monitoring data demonstrates that this has enabled the programme to involve a good range of businesses of different sizes:

- 85 large companies and 123 SMEs have been involved in individual CR&D projects
- 48% of projects involve a large company and a micro-small or both a micro/small and a medium sized business (Table 3-1).

Table 3-1: Combinations of businesses involved in CR&D (W2) projects

Combinations of businesses involved	No. of projects	% of all
Micro/Small only	20	33%
Large + Micro/Small	15	25%
Large + Medium + Micro/Small	14	23%
Medium + Micro/Small	5	8%
Large + Medium	4	7%
Large only	2	3%

Source: SQW analysis of TFI monitoring data

3.47 The data also show the programme has ensured a good degree of cross-sectoral collaboration:

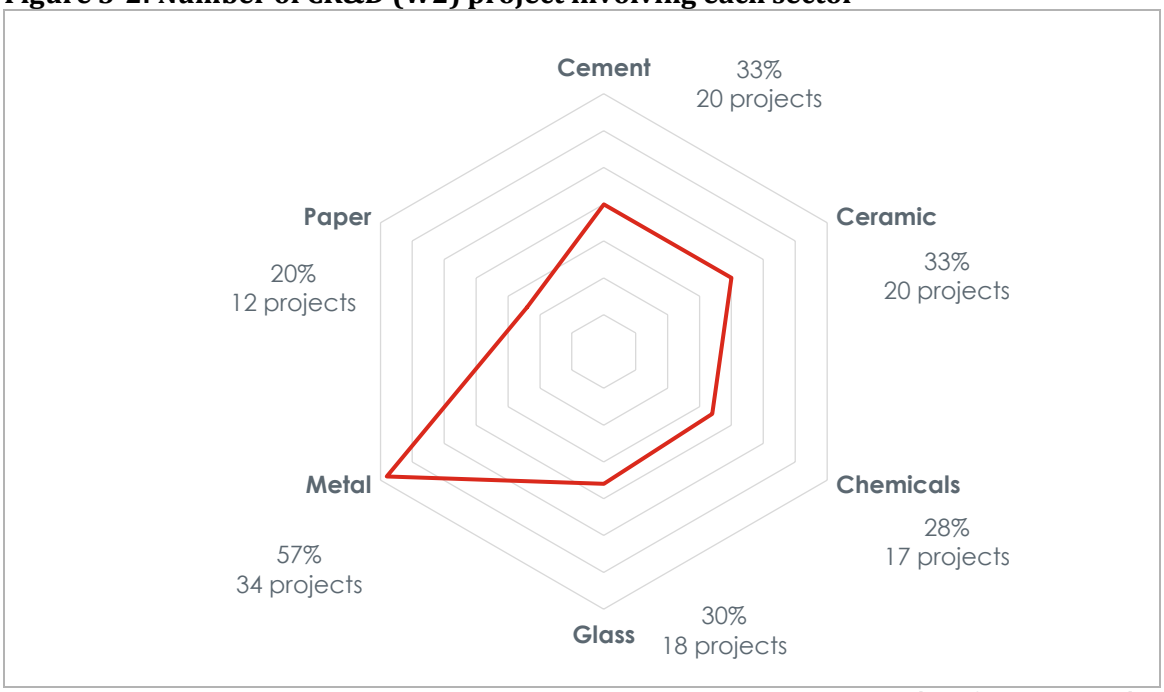
- Table 3-2 shows that half of all projects have two sectors engaged and 20% of projects have more than two sectors engaged
- Figure 3-2 shows that the metal sector is represented in the most projects (57%) whereas paper is represented in the fewest, at 20%, which is perhaps still higher than would be expected given feedback from stakeholders on the relevance of cross-sectoral collaboration for the paper sector.

Table 3-2: Number of sectors engaged per CR&D project (W2)

Sectors engaged per project	No. of projects	% of all
1	18	30%
2	30	50%
3	8	13%
4	2	3%
6	2	3%

Source: SQW analysis of TFI monitoring data

Figure 3-2: Number of CR&D (W2) project involving each sector



Source: SQW analysis of TFI monitoring data

3.48 Consultation evidence showed a majority of businesses were supportive of cross-sectoral collaboration. While some had worked in this way before, it was a new experience for a lot of businesses (in a way that research collaborations were not). The general perception across all interviewee groups was that these collaborations were valuable. One stakeholder interviewed said: *"Very rarely does the metal sector have contact with the chemical or cement sector – even though there are common challenges. TFI is changing that."*

3.49 However, the data indicates that, when given the option to pursue a single-sector project, there was considerable demand (28% of projects (17) only covered one sector), suggesting businesses like the convenience of undertaking their own focused project. Moreover, there was **a degree of scepticism about the potential for collaboration across sectors where process-similarities were not evident, for example the paper and chemicals industries** (and despite the fact that they are respectively involved in 12 and 17 cross-sectoral projects). However, interviewees still considered that collaboration between companies of different sizes but within the same sector (such as chemicals) would be beneficial.

4. Progress towards outcomes and impacts

Summary

- There is limited evidence on outcomes and impacts at this stage in the programme. However, there is encouraging evidence on TFI contributing to an increased shared FI identity, and willingness among companies and academics to innovate and collaborate. These interim outcomes demonstrate that the logic of the programme holds to this point and there is a reasonable expectation that longer-term outcomes and impacts will be achieved.
- Other outcomes include changing the terms of the debate about how to make the FI more competitive and sustainable, and improving the knowledge base in relation to FI.
- Progress has been achieved by addressing the market failures identified in the design of the programme, such as by de-risking investment in innovation by providing a pilot facility for companies to trial new technologies.
- Importantly, additionality is perceived to be high in terms of speed, scale and quality, with 83% of consultees reporting full or partial additionality.

4.1 This section presents early findings on the outcomes and impacts of the TFI Challenge. The next phase of the evaluation will undertake a full impact assessment.

4.2 Due to the fact the programme is still mid-delivery, with some activities only recently launched, there are few outcomes and impacts evident at this point. However, there is early progress in terms of an increased shared FI identity, and willingness among companies to innovate and collaborate than otherwise would have been the case. Academics are also more willing to collaborate, or more specifically, are more able to collaborate because the programme has extended their network (Annex C presents progress against all outcome and impact metrics). The interim outcomes of shared identity and willingness to collaborate should be taken as evidence that the programme is working as planned.

4.3 Those involved in and observers of the programme have reported positively on these outcomes. One stakeholder observed: *"It's the first time I have seen the FI come together as part of an initiative, so it's definitely created more of a shared identity."* A delivery team member observed how the willingness to collaborate has translated into increased scoping of potential projects by some members of Glass Futures, some of which have sought funding from other sources such as the Industrial Energy Transformation Fund.

4.4 Other positive outcomes include:

- Changing the terms of the debate within industry, academia and government to understand the nature of the challenges facing the FI, the importance of addressing them, and routes to doing so. One consultee reported that the Challenge had stimulated government to think more about materials than previously
- Improving the knowledge base for FI by bringing together representatives from across the sectors and researchers.

4.5 The general consensus was that emerging outcomes should give confidence that longer-term outcomes can reasonably be expected. There are also likely to be outcomes and impacts that are indirectly a consequence of the programme but hard to attribute. For example, the demonstration of the government's commitment to innovation for the FI is likely to have played a role in events such as Modern Karton's £600m investment in a new paper mill at Shotton Mill.

4.6 Emerging benefits from the different workstreams are described below.

1. Glass Futures

4.7 Qualitative feedback from interviews with the Glass Futures delivery team, wider stakeholders and businesses suggests that the development of Glass Futures is broadly welcomed. The model appears to be validated through the development of collaborations that are applying for funding of innovation projects via TFI competitions (eight projects have been funded by CR&D2) and other funding streams and early success in attracting members.

4.8 Membership is a key aspect of the sustainability strategy. Fifty business members have been recruited to date, including national and international companies and glass supply chain and final retailers. Stakeholders were positive about membership enrolment to date and anticipated that it may grow larger than initially anticipated. One membership project, which is focussing on technologies for Carbon Capture and Underground Storage (CCUS), is already underway.

4.9 Stakeholders have been positive about progress to date. One described it as a *"success story of collaboration between local and national government, industry and academics".* Another reported that is attracting attention both nationally from other sectors and internationally. It represents a considerable investment in the glass sector to reduce the risks for companies of developing new resource efficient technologies and so accelerate innovation and new collaborations within glass and across other sectors, increasing business investment in R&D and FDI. Expectations of what the facility can deliver in the long-term are high:

"Once complete, the facility will be a true legacy of TFI, and will continue to generate impact long after the programme is complete." ***Glass Futures delivery team member***

2. CR&D

4.10 All funding has been awarded for the six CR&D competitions, which were intended to encourage collaboration between companies and researchers in FI to address common challenges and opportunities. As projects are beginning to finish, outputs are being delivered, and there are expectations that outcomes will follow.

4.11 The standard of applications was seen as high and a member of the delivery team described it as *"challenging to select the successful [applications]"*. Sixty-five awards were made (of 114 applications), 60 of which progressed to becoming established projects (five were either terminated or withdrawn after the award was made).

4.12 In section 3, we reported on progress against collaboration outputs, for example that fifty-two universities/RTOs are involved in projects and projects have a good mix of large and small/medium companies and a sectoral mix. As yet there is no quantified evidence on collaboration outcomes, namely willingness among industry and academia to collaborate. However, there is consultation evidence that a majority of businesses interviewed (55%) and nearly all academics are more willing to collaborate because of their experience of the programme.

4.13 Projects are at various stages so outcomes and impacts are not anticipated at scale at this stage. As of September 2022, 29 of the 60 are classed as 'finished' (48%) and 24 are 'live' (40%). The remaining 7 are in the set-up stage (12%). However, TFI's internal 'in-flight' benefits survey of 39 grant recipients provides some indication of expected outcomes:

- 27 respondents (69%) anticipate their project will foster new relationships across the foundation industries
- 16 respondents (41%) anticipate publishable findings after the project
- 37 respondents (95%) anticipate that their project will in some way reduce CO2 emissions
- 13 respondents (33%) anticipate that the project will help/has helped with equality, diversity and inclusion (EDI) initiatives.

4.14 To date there is limited evidence on technology progression, but the delivery team reported that *"lots of projects [funded by the CR&D programme] have produced commercially viable products".*

4.15 One unanticipated benefit of the programme is that the competitions have tended to award funding to SMEs and RTOs instead of larger companies. In many cases the larger organisations involved in projects do not actually receive any funding themselves and are engaged for the benefits of collaboration rather than direct reduction of the financial risk of investment in innovation.

3. Transfire (the Hub)

4.16 Transfire has progressed more slowly than anticipated but is already demonstrating progress towards outputs and outcomes in terms of papers published and partnerships created.

4.17 The Hub was intended to facilitate knowledge transfer from academics to companies, via funded collaborations between industry and universities and a programme of work to address technological and non-technological barriers, ultimately supporting the development of new technologies to solve cross-sectoral issues. To date, Transfire has conducted activities across three workstreams:

- Workstream 1 involves mapping the current flows of energy and material across the foundation industries
- Workstream 2 involves discovering/creating new flows of materials across the foundation industries
- Workstream 3 involves identifying suitable sites for new foundation businesses.

4.18 Transfire has reported some encouraging progress towards outcomes and impacts:

- Three academic papers have been published
- 20 jobs have been created (within the Hub; not known if these are additional)
- 75 collaborations and partnerships have been created.

4.19 However, progress on securing additional grant funding appears slow: Transfire reporting indicates £0.1m is currently secured against a target of £2.5m, although this may not include in-kind contributions (exact figures are being confirmed). Generally it is felt that the workstream is progressing more slowly than planned, which is attributed to slow recruitment of academics. However, interviewees anticipate momentum will build and outcomes and impacts will begin to flow.

4. Sector Strategy and Network+

4.20 WS4 functions as an enabler for the other workstreams so it may be hard to attribute longer-term outcomes to it but the delivery team and a small number of businesses and stakeholders reported good progress in terms of supporting the development of a sector identity.

4.21 WS4 was focused on the creation of a (stronger) FI identity through the formation of a (stronger) industry and academic community to generate more effective collaboration between sectors and between business and academia. It has two elements: sector strategy activities and Network+.

4.22 Together these elements have made significant progress in engagement and networking. As of June 2022 the network had attracted 556 members (64% academics, 36% from industry), one academic paper had been prepared and another one contributed to, four funding calls

delivered, including two intended to support early career researchers, and a future leadership development programme for 40 women initiated. One unexpected outcome has been a member of the network appearing in a short film for the BBC.

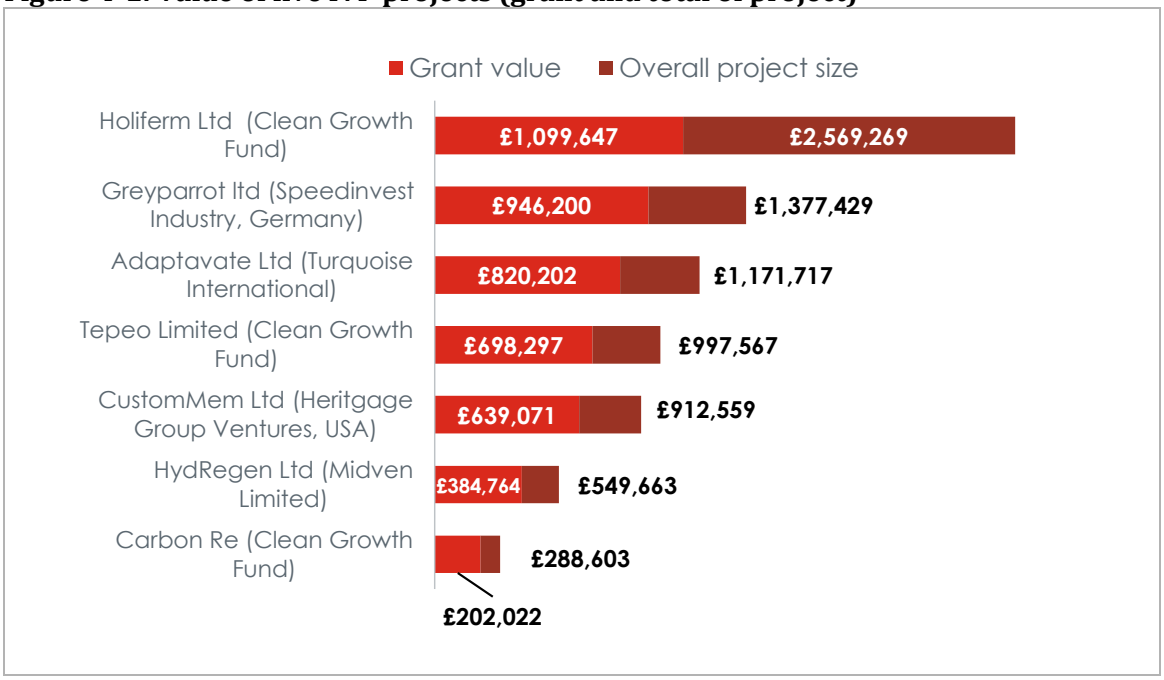
4.23 The relevance of the workstream was challenged during the Challenge design phase but from the perspective of the delivery team it is really driving engagement in the Challenge overall. One member of the delivery team stated they had *"never seen as much industry engagement [as that seen in Network+], even compared to KTN [Knowledge Transfer Network]"*. It may be challenging to attribute outcomes and impacts directly to WS4 given its function as an enabler across the whole programme.

5. Investor Partnership Programme

4.24 WS5 has successfully delivered outputs (investors and projects) but there is not yet evidence on outcomes.

4.25 WS5 was about attracting more private equity companies to invest in the FI by identifying investors and matching them with companies to deliver new innovations and technologies. To date, it has been successful in delivering these outputs, namely five investors and seven projects (with two waiting to start). Figure 4-1 shows the value of the live projects according to the grant value and other private funding. However, progress towards outcomes and impacts in terms of technological developments within the projects and the establishment of an investment community remains to be seen.

Figure 4-1: Value of live IVP projects (grant and total of project)



Source: Transforming Foundation Industries Investor Partner programme – UKRI

Learning

4.26 Progress to this point has been supported by a number of factors, some of which have been highlighted earlier in this report:

- Involving industry in the design has helped frame government priorities in a way that matches industry priorities, particularly in terms of energy and resource reduction
- The blend of activities across the five workstreams has offered multiple 'doors to entry' for industry and academia
- Management and governance has been efficient and appropriate, offering participants support and information when required
- Match-funding from the government has drawn in private sector investment as it has reduced the economic risk of undertaking innovation
- Similarly, access to the Glass Futures facility has reduced the cost of undertaking innovation for some companies
- Network+ and some of the sector strategy work has provided information to potential participants about the research base and where to find collaborators, reducing this information failure
- The programme has been flexible in terms of awarding CR&D funding to a range of projects of different duration and area of focus, ensuring a wide spread of potential technology developments.

4.27 The most significant barrier to progress has been the availability of the right staff with the right skills. This has affected the capacity of Glass Futures and the progress of CR&D projects. There are challenges in estimating what resource might be needed when, particularly for Glass Futures (which has grown its headcount five times in two years – from 8 to 41 employees). Mobilisation of the Innovation Hub was also slowed due to lengthy recruitment timeframes for academics. The programme has been able to make limited attempts to mitigate recruitment issues by helping projects network to fill skills gaps but ultimately there are challenges in terms of the skills available in the UK.

Overall progress including additionality and other factors

4.28 Overall, the TFI programme has delivered well on outputs to date and is beginning to see emerging outcomes. Its role has been to support these achievements at greater pace, scale, and quality than would otherwise have been the case. In the main, the reason it has been able to do this is through de-risking activities, through provision of pilot facilities, project-funding or access to skills and expertise. In general, the perspective of participants and stakeholders is that the additionality of the programme is high: 38% of consultees reported full additionality and 45% reported partial additionality (Table 4-1). While there is likely to be a

degree of optimism bias in these responses, such positive feedback presents an encouraging picture of the work of the Challenge.

4.29 TFI is recognised as filling a long-term policy gap and is the only targeted government support for these sectors, particularly as a group of industries: *"There might have been developments within each FI but what TFI has been critical for is bringing them all together – it's hard to imagine a scenario in which this would have happened otherwise. Industrially, there is no set up to allow this to happen."* (Wider stakeholder)

4.30 However, progress across sectors is uneven, with one consultee commenting that *"in terms of achieving its goals so far from the chemical sector it has not achieved anything so far. I think the limited engagement [from the chemicals sector] is part of it and I suppose some of the other funding calls like on the Hydrogen economy were more in tune to making the sector more sustainable than the TFI. In retrospect a lot of the calls weren't addressing the big issues for the sector."*

Table 4-1: Reported additionality of the TFI Challenge

Would the benefits experienced to date have been achieved without TFI?	N	%
None of the benefits would have happened without TFI	22	38%
The benefits would have happened anyway, but they would have taken longer to achieve	15	26%
The benefits would have happened anyway, but on a smaller scale	8	14%
The benefits would have happened anyway, but they would have been of lower quality	3	5%
The benefits would have happened anyway, over the same time period and at the same scale	3	5%
Don't know	0	0%
Total responses	51	

Source: SQW

4.31 A small sample of businesses provided qualitative feedback indicating that either none of the current benefits would have happened without TFI, or their project may still have gone ahead in some form, but not to the same scale and likely lacking this level of collaboration, meaning outputs would be smaller and of lower quality. The push for projects to be cross-sectoral and collaborative between industry and academia was seen to be an important driver of outcomes.

"One of the things is that TFI has helped with is promoting collaboration which has reduced competition between companies. Having multiple sectors involved is giving people access to people they've not spoken to before. And more open relationships. This would not have happened if there had been a challenge for just the ceramics industry, for example."
Business interviewee

4.32 Additionality was perceived to be particularly high in terms of TFI's contribution to Glass Futures: aside from the £15m contribution from TFI, there was only the much smaller contribution from the Liverpool City Region Combined Authority, which would have meant a facility on a much smaller scale. Aside from establishing the facility, TFI's contribution has been to catalyse the receipt of other funds, including a £20m investment from a pension fund investor.

4.33 The programme's additionality is likely to be lower in terms of the Investor Partnership strand. While the projects funded in this workstream are seen to be of a high quality, for this reason they may have been funded by investors without the additional appeal of government funding. In any case, there is a case to be made that the government contribution could have been in the form of a loan or equity rather than a grant, ensuring that longer-term, the public sector would be re-paid. However, there has been considerable learning generated from TFI's experience of implementing this strand, which has been used to inform Innovate UK's further development of the model.

4.34 Other factors have been relevant to the achievement of outputs and outcomes to date. The increasing importance of the net zero agenda is clearly responsible for interest in and pursuit of innovations to raise the environmental sustainability of the FI which runs parallel to increasing demand for greater resource and energy efficiency to cut costs (driven by increasing energy costs and supply chain disruption) and increase the competitiveness of the FI. In this respect, one consultee observed, *"Any benefits being achieved are probably triply important."* However, it is worth noting that there is still an immense distance to travel in terms of making any noticeable difference to these issues at a sector level, and the Challenge will only be one small part contributing to this technological shift. As one consultee noted, there are *"huge amounts more to be done. It's always going to be the case that TFI is just a starting point. Within the understanding of that I would say yes progress is being made."*

4.35 In particular cases, previous experience of businesses in technological innovation is a relevant factor in achieving outcomes.

Equality, diversity and inclusion (EDI)

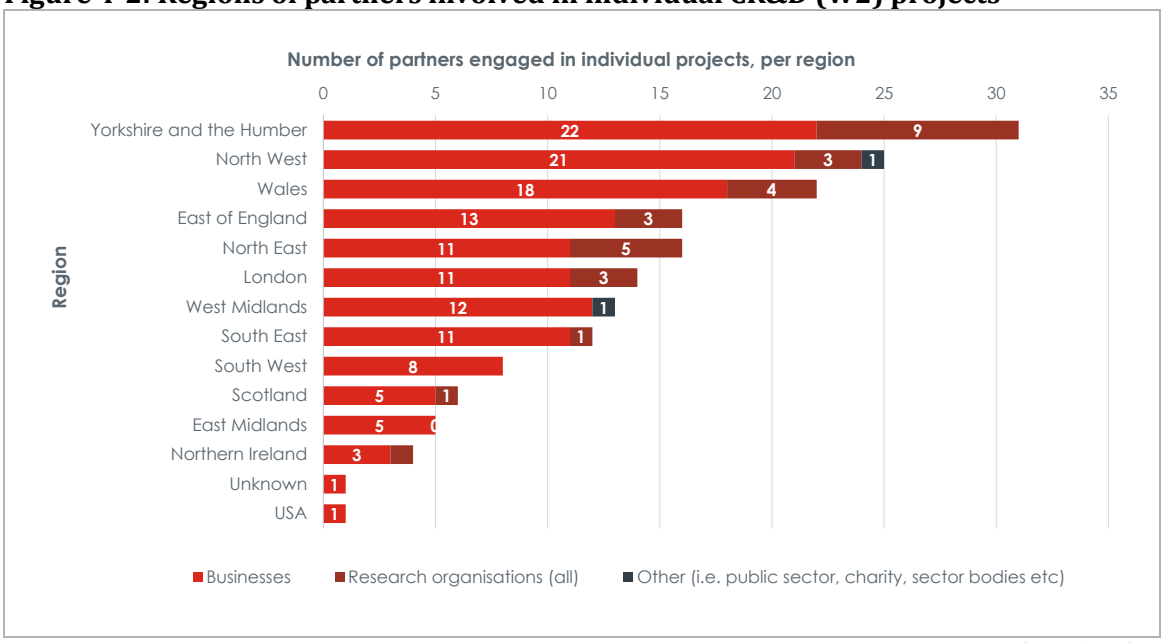
4.36 EDI is considered to be an important element of the Challenge due to the lack of diversity caused by historical employment patterns and existing labour availability, which limit the availability of skills for the sector. EDI is a key feature of the design and delivery of TFI, for example it is assessed as part of the monitoring of funded projects. As a topic on its own it has been incorporated into delivery of sector strategy studies, events and research as part of WS4. Specific initiatives include:

- A report based on an EDI workshop in March 2022 as part of Network+ covered a range of EDI related issues in the six sub-sectors as well as making a series of recommendations.
- An EDI working group established in June 2022 as part of Transfire to create a playbook of EDI best practice specifically for the FI.

- A Women's Leadership Development programme initiated in May 2022 to fund 40 women in the FI to reach senior and technical positions.
- A planned apprenticeship recruitment programme will have an EDI focus, with recruitment strategies targeting underrepresented groups.

4.37 The location of the majority of FI businesses means that efforts to support the sector align with levelling up priorities: Yorkshire & Humber, North West and Wales are the most represented regions in terms of partners involved in CR&D2 projects (Figure 4-2).

Figure 4-2: Regions of partners involved in individual CR&D (W2) projects



Source: SQW analysis of TFI data

4.38 Stakeholders gave positive feedback on the Challenge's efforts to promote EDI and was seen as following best practice: *"whenever they've considered adding new elements to TFI, EDI implications have been part of these discussions – rather than deciding what they're doing, and then going 'OK, now we need to do the EDI bits'".*

4.39 In terms of early impacts from its initiatives, feedback from a small sample of businesses indicated that a majority of businesses do consider EDI, half due to existing company policy but half because of the influence of the TFI programme. However, it was recognised that the Challenge is likely to have a small impact on this deep-rooted issue: *"You can't change the world overnight but can move towards greater practices and awareness."* (Business interviewee).

5. Emerging conclusions and next steps

5.1 This process evaluation found that the TFI programme has been designed and delivered well to date. The leadership, direction and support of the TFI delivery team has contributed to programme objectives generally in an effective and efficient way. This is a positive finding given the uncertain and volatile market conditions (for example, the energy crisis) that have acutely affected the FI. In this context, most consultees perceived programme delivery as pragmatic and responsive. This should be borne in mind in future programme development.

5.2 Key to effective design and delivery has been the involvement of industry in co-developing the programme, the strategy for creating a shared identity across the FI sub-sectors, and the different strands/activities that businesses and academics could collaborate on (indeed collaboration is the pre-requisite to many activities). A minority of consultees identified areas for improvement: the slight imbalance between the sectors within the programme (e.g. the development of a glass facility and less opportunity for the paper sector to collaborate given fewer process commonalities with other sectors), the need for more promotion, and allocating more resource to improve the capacity of the TFI delivery team.

5.3 The early evidence suggests that programme activities have led to key outputs and some early outcomes as set in the TFI logic model. For example, there has been an increased willingness (and actual) collaboration and innovation among FI companies – and between FI companies and academia. Crucially, there is now a perception amongst all consultee groups that there is a more recognised/ established shared FI identity because of TFI.

5.4 Importantly, the programme activities are translating into outputs and early outcomes. Most consultees report these to be partially additional i.e. outputs and outcomes have occurred more quickly, are of greater scale and quality because of TFI, with 83% of consultees reporting full or partial additionality (albeit with some optimism bias). It will be important for the programme to ensure this continues to be the case.

5.5 A key obstacle to this will be market conditions that may hinder innovation and collaboration. It will therefore be important for TFI to ensure that investment in innovation is seen as the route out of the economic crisis rather than be seen as another cost for firms. This message needs to be actively communicated going forward (backed with short and longer-term support, whilst recognising resource constraints). Notwithstanding this, we highlight the following areas for learning and improvement:

- Reflect on learning and outputs from all workstreams but particularly WS4 to increase cross-workstream sharing of learning and engagement.
- Develop a more focused monitoring system that brings data and evidence from the multiple range of sources (Glass Futures, Transfire and Network+ reports, CR&D and IVP monitoring officer reports and benefits survey responses) into a single, streamlined and transparent reporting tool

  - This would support monitoring of progress at workstream and an overall Challenge level and provide a critical input to the final impact phase of the evaluation. Such a tool would clearly set out indicators (or KPIs), targets and progress.
- Ensure that collection of contact details and permissions for programme participants is comprehensive across all workstreams and activities to ensure the evaluation is able to capture outcome and impact data to supplement data from the monitoring system.
- Finally, is there scope for follow-up on projects that impact energy costs and other hot issues in the shorter term, as well as advancing longer term progress towards sustainability/ net zero?

Next steps

5.6 In January 2023, the evaluation will move into the final impact phase. This phase will involve a range of research including: analysis of monitoring data; analysis of sector indicators from secondary data sources; modelling of environmental and economic change; comparison of the FI with international benchmarks; a large scale telephone survey of business participants in the programme; and interviews with the delivery team, businesses, academics, the glass facility and users, investors and stakeholders. A final report will be produced in March 2024.

Annex A: Progress against objectives

Table A-1: Summary assessment of TFI's progress against objectives

Objective	Summary of progress
1. Accelerate innovation and new collaborations across the sectors via delivery of Pilot Scale facilities and CR&D	• 60 CR&D projects funded. • 265 partners engaged. • 48 projects involve 2 or more sectors. • Glass Futures construction on target. • A majority of businesses* reporting increased opportunities to collaborate with other businesses and increased skills re. innovation and/or net zero. A minority* expecting to achieve patents, others expecting reduced energy usage and waste.
2. Increase multi/inter-disciplinary research and innovation across the sectors through supporting development of the foundation industries as a sector	• Range of activities planned / in delivery that are seeking to build the sector's identity, diversity and skills e.g. funding calls for small projects to support early career researchers, workshops and webinars. • A majority of businesses* reporting increased recognition of and identification with the FI, with many not familiar with this term prior to TFI. • A small number of academics** reporting increased sense of FI research community. • A majority of businesses* and academics** reporting increased opportunities to collaborate with (other) businesses and academics. • Businesses* reporting increased skills related to innovation and/or net zero (55%).
3. Develop closer academic and industry links through programmes dedicated to technology transfer	• 5 research projects underway (WS3). • 6 engagement events planned for 22/23 (WS3). • 52 research organisations engaged in CR&D projects (WS2). • Launch delayed by slow recruitment of academics. • A majority of businesses* and academics** reporting increased willingness and opportunities to collaborate with (other) businesses and academics.
4. Accelerate growth of new technology and fast-growing businesses across the value chain through co-investment with Private Equity	• Five investors recruited. • Seven projects live (one in set-up and one delayed): approximately 70% grant funding, 30% private investment. • A few businesses* reporting actual/expected increased private equity funding.
5. Increase FDI in the UK and business investment in R&D via CR&D and pilot scale facilities	• 60 CR&D projects: 51% grant funding, 49% company investment. • Glass Futures construction scheduled for completion in January 2023 (a year behind schedule due to Covid-related delays). Has raised additional investment.

*Source: SQW based on data from TFI. *Based on qualitative feedback from a sample of 20 businesses participating in CR&D projects. **Based on qualitative feedback from a sample of five academics.*

Annex B: Progress against output metrics

Table B-1: Progress against Transforming Foundation Industries ISCF input and output metrics

#	Indicator	Target	Progress	Comment
Inputs				
1	Amount of ISCF funding (by workstream) (£)	n/a	• Glass Futures (W1): * • CR&D competitions (W2): £41.4m • Transfire Hub (W3): * • Network+ and Sector Strategy (W4): * • Investor Partnerships (W5): £4.8m	-
2	Amount of industry matched funding (by workstream) committed and spent (£)	n/a	• Glass Futures (W1): £1.1m* • CR&D competitions (W2): £39.8m • Transfire Hub (W3): £4.4m • Network+ and Sector Strategy (W4): * • Investor Partnerships (W5): £2.02m (minimum)	-
3	Amount of other public funding (by workstream) (£)	n/a	*	-
Outputs				
4	Glass pilot scale facility delivered in terms of progress against milestones (W1)	Collaboration between 5 glass sector organisations At least two international partners involved in the delivery of the facility £22m match funding reached Pilot glass facility operational by 2023, with programme of	• 50 business members, national and international including Siemens, Heineken, Diageo. • Industry investment of £1.1m (as of June 2022). • Construction is on course to finish by 20th January 2023 when the equipment fit-out programme will commence. • 14 projects underway.	• Progressing well on membership. • Behind on match-funding. Construction delayed due to Covid.

#	Indicator	Target	Progress	Comment
		R&D projects underway and a sustainable business plan		
5	Number of CR&D competitions (W2)	n/a	• 6 competitions run as of September 2022: ➢ Fast Start ➢ Resilient Recovery (Covid-19) ➢ Large CR&D ➢ Small Strand 1 ➢ Small Strand 2 ➢ Demonstrator.	-
6	Number of CR&D competition applications (W2)	n/a	• Fast Start: 22 applications, 13 accepted (59% of applicants), 9 rejected. • Resilient Recovery (Covid-19): 43 applications, 21 accepted (49%), 22 rejected. • Large CR&D: 11 applications, 7 accepted (64%), 4 rejected. • Small Strand 1: 17 applications, 12 accepted (70%), 5 rejected. • Small Strand 2: 7 applications, 4 accepted (57%), 3 rejected. • Demonstrator: 14 applications, 8 funded (57%), 6 rejected.	-
7	Number of CR&D competition awards (W2)	n/a	• 65 awards made to successful applicants in total, with 60 projects being established and 5 being withdrawn or terminated, as of September 2022. • Fast Start: 12 projects finished, 1 withdrawn. • Resilient Recovery (Covid-19): 18 projects finished or live, 1 terminated and 2 withdrawn.	-

#	Indicator	Target	Progress	Comment
			• Large CR&D: 7 projects live, 0 withdrawn or terminated. • Small Strand 1: 12 projects live or finished, 0 withdrawn or terminated. • Small Strand 2: 3 projects live, 1 withdrawn. • Demonstrator: 7 projects in set-up, 1 live, 0 withdrawn or terminated.	
8	Value of CR&D grants awards (£)	£13m	£41.4m in total Fast Start: £2.5m (6%) Resilient Recovery (Covid-19): £6.6m (16%) Large CR&D: £7.2m (17%) Small Strand 1: £540k (1%) Small Strand 2: £563k (1%) Demonstrator: £24.1m (58%)	• Exceeding target.
9	Number of partnerships developed, including cross-sectoral (W2)	40 partnerships (commercial and non-commercial) between organisations from different foundation industry sectors	• 265 partners engaged (CR&D2), including: ➢ 208 businesses ➢ 52 Universities/RTOs ➢ 5 partners classed as 'other' including charities and industry organisations.	• Exceeding target.
10	Number of projects progressed / completed (W2)	30 feasibility projects completed successfully 7 CR&D projects at a mid-point review 5 cross sector demonstration projects started	• As of September 2022, of the 60 successfully established projects, 29 are classed as 'finished' (48%) and 24 are 'live' (40%). The remaining 7 are in set-up stages (12%).	• Exceeding target.
11	Number of industry-research collaborations established (W3)	150	• 75 collaborations and partnerships established, involving 12 research organisations and over 70 industry partners.	• Good progress.

#	Indicator	Target	Progress	Comment
12	Number of industry-research projects progressed/completed (W3)	n/a	• 5 research projects started, examining refractories, casting sand, new business models, continual improvement and plastic re-use.	-
13	Number and types of reports produced (e.g. sector strategy, skills)	30 (Transfire) 20 (Network+)	• Report published summarising the findings of a workshop focused on EDI in the Foundation Industries, 3 academic papers published (WS3). • 1 academic paper published and 1 report contributed to (WS4).	• Target for Transfire is for 2024 so some progress.
14	Number of industry and academic engagement activities delivered (W4)	20 combined industry and academic engagement activities delivered	• 6 industry and academic engagement and networking events delivered. • 1 Transforming Foundation Industries forum delivered.	-
15	Number of research projects progressed/ completed (W4)	20 early stage (TRL2-3) research projects progressed/ completed through Network+	• 21 projects funded across 3 calls.	• Exceeding target.
16	Skills and training courses progressed/completed (W4)	n/a	• Women's Leadership Programme received applications from 95 individuals, with 40 successfully funded.	-
17	Number and type of firms funded (W5)	n/a	• 9 projects funded across all 6 foundation industries (with one delayed and one in set-up). • The number of projects engaging with each sector is: Chemicals (4 projects), Metal (3), Glass (2), Paper (2), Cement (1), Ceramic (1).	-
18	Value of Government funding for firms with resource/energy efficiency technologies (£) (W5)	£5m	• £4.8m.	• Good progress.

#	Indicator	Target	Progress	Comment
19	Value of private funding for firms with resource/energy efficiency technologies (£) (W5)	£5m	• +£20m [requires updated figure].	• Exceeding target.
20	Privately funded projects progressed against milestones (W5)	n/a	• 7 projects have started, with 1 delayed and 1 in set-up.	-

*Source: SQW based on data from TFI including: Glass Futures Quarterly report April-June 2022; Live Projects overview – accessed 26/9/2022; ISCF Transforming Foundation Industries Research and Innovation Hub report April 2022; ISCF Transforming Foundation Industries Network+ report June 2022. *Updated data expected from TFI.*

Annex C: Progress against outcome and impact metrics

Table C-1: Progress against Transforming Foundation Industries ISCF outcome and impact metrics

	Indicator	Progress	Future source of evidence
Outcomes			
1	Operationally sustainable glass facility (W1)	• Recruitment of 50 business members, national and international including Siemens, Heineken, Diageo, covering glass supply chain and final retailers.	• Glass Futures quarterly reporting.
2	Level of usage by member organisation of glass facility (days) (W1)	• n/a.	• Glass Futures quarterly reporting, consultations with stakeholders.
3	Technologies accelerated to market (TRL progression)	• n/a.	• Inflight benefits survey tracks "*new commercialised products and/or services*".
4	Number of new technologies developed	• Approximately 53 new products or services anticipated by 90% of (35/39) CR&D 2 beneficiaries that responded to the inflight benefits survey. • Average of 1.5 new products and services per respondent.	• Inflight benefits survey tracks "*new commercialised products and/or services*". • Transfire quarterly reporting.
5	Number of papers published relating to research on FI	• 3 academic papers published (Transfire). • 1 academic paper published and 1 contributed to (WS4).	• Inflight benefits survey tracks "*research papers*". • Transfire and Network+ quarterly reporting.
6	Number of patents generated on innovation related to FI	• n/a.	• Inflight benefits survey tracks "*IP licenses*". • Transfire quarterly reporting.

	Indicator	Progress	Future source of evidence
7	Patent applications	• 26% of CR&D 2 beneficiaries who responded to the inflight survey (10/39) anticipated they will be applying for IP licenses as a result of the project.	• Secondary dataset: OECD patents by technology (for context not programme data).
8	Establishment of a shared FI identity (perceptions of internal FI and external stakeholders)	• Positive qualitative feedback from a small sample of participant businesses.	• Consultations with participating firms, academics and other stakeholders (using Likert scale question about identity and/or cohesiveness). • Survey of companies.
9	Willingness among FI companies to innovate	• Positive qualitative feedback from a small sample of participant businesses.	• Survey of companies. • Consultations with participating firms, academics and other stakeholders (including asking for relative importance of innovation compared to other business priorities).
10	Willingness among FI companies to collaborate	• Positive qualitative feedback from a small sample of participant businesses.	• Survey of companies. • Consultations with participating firms, academics and other stakeholders (including asking relative importance to other priorities).
11	Willingness among FI companies and academics to collaborate	• Positive qualitative feedback from a small sample of participant businesses and academics.	• Survey of companies. • Consultations with participating firms, academics and other stakeholders (including asking relative importance to other priorities).

	Indicator	Progress	Future source of evidence
Impacts			
12	Number of new collaborations between companies across FI and with the academic base	• 52.	• Programme monitoring counts collaborations but not whether they are new.
13	Value of private R&D investment on activity supported by the Challenge (£)	• Matched funding for projects is shown below. Additional private investment is not yet known. ➢ Glass Futures (W1): £1.1m ➢ CR&D competitions (W2): £39.8m ➢ Transfire Hub (W3): [requires information from TFI] ➢ Network+ and Sector Strategy (W4): [requires information from TFI] ➢ Investor Partnerships (W5): £6.6m.	• Inflight benefits survey captures "*company expenditure on R&D*" and "*private equity*".
14	Value of private R&D investment at firm-level (£) (evidence for programme and context)	• 82% of CR&D 2 beneficiaries who responded to the inflight survey (32/39) stated they expected to increase their expenditure on R&D as a result of the TFI project.	• Inflight benefits survey captures "*company expenditure on R&D*" and "*private equity*". • Secondary dataset.
15	Value of private R&D investment at wider sector level (£) (for context)	• n/a.	• Secondary dataset.
16	Value of private R&D investment/GVA (for context)	• n/a.	• Secondary dataset (explore Beauhurst, potentially FAME database).
17	Value of foreign direct investment (FDI) secured by the Challenge (£)	• n/a.	• Inflight benefits survey captures "*FDI*". • Secondary dataset.
18	Value of FDI secured at firm level (£) (for context)	• n/a.	• Potentially secondary dataset (2 digit SIC code) (Beauhurst) • Survey.

	Indicator	Progress	Future source of evidence
19	Value of FDI secured at wider sector level (£)(for context)	• n/a.	• Secondary dataset.
20	Value of FDI/GVA (£)(for context)	• n/a.	• Secondary dataset.
21	Technologies developed and adopted across the FI – progression through TRLs	• n/a.	• Inflight benefits survey tracks "*new commercialised products and/or services*".
22	Amount of material used by industry	• 95% of CR&D 2 beneficiaries who responded to the inflight survey (37/39) stated they expected to reduce their waste as a result of the project.	• Inflight benefits survey tracks "*waste/resource*".
23	Energy consumption by industry	• 82% of CR&D 2 beneficiaries who responded to the inflight survey (32/39) stated they expected to reduce their energy consumption as a result of the TFI project.	• Secondary dataset: ONS, energy use by industry, source.
24	Emissions intensity (GHG emissions per real unit of GVA)	• n/a.	• Secondary dataset: ONS, energy use by industry, source.
25	Number of skills shortages (vacancies) at firm level	• 85% of CR&D 2 beneficiaries who responded to the inflight survey (35/39) stated new skills will be attained by their team as a result of the project, ultimately addressing skills shortages.	• Inflight benefits survey tracks "*new skills*".
26	Incidence of skills shortages (vacancies) at sector level	• n/a.	• Secondary dataset: Department for Education, Employer Skills Survey.
27	Senior management have a plan/ taking action on innovation and net-zero	• n/a.	• Consultations with participating firms. • Baseline and end of programme surveys.
28	Senior management have the skills to deliver innovation and net-zero successfully	• n/a.	• Consultations with participating firms.

	Indicator	Progress	Future source of evidence
			• Baseline and end of programme surveys.
29	Employment by sector	• Creation of 41 FTE jobs within Glass Futures. • Creation of 20 jobs via Transfire.	• Inflight benefits survey tracks "*new and safeguarded jobs*". • Baseline and end of programme surveys • Secondary datasets: ONS Annual Business Survey, Working Future (Department for Education), Business Register and Employment Survey (ONS)
30	Value of turnover (£)	• n/a.	• Baseline and end of programme surveys • Programme monitoring • Secondary datasets (from FAME database if UKRI can provide access): ONS Annual Business Survey
31	Gross operating profit (£)	• n/a.	• Baseline and end of programme surveys • Programme monitoring?
32	Gross operating surplus (GVA minus employment costs) (£)	• n/a.	• Secondary dataset: ONS Annual Business Survey.
33	Share of exports in total turnover (%)	• n/a.	• Baseline and end of programme surveys • Programme monitoring (not asked yet as not relevant) • Secondary datasets: Eurostat Comext.

	Indicator	Progress	Future source of evidence
34	Export market share (UK as a share of global exports)	• n/a.	• Secondary datasets: calculated from Eurostat Comext, UN Comtrade and Annual Business Survey (ONS).

Source: SQW

SQW

Contact

For more information:

Osman Anwar
Director, SQW
T: +44 (0)131 243 0729
E: oanwar@sqw.co.uk

48 Melville Street
Edinburgh
EH3 7HF

www.sqw.co.uk

About us

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