Annex A. Challenge-level baseline reports reviewed

The following is a list of Challenges and programmes for which evaluation baseline reports were submitted and reviewed during this baseline measurement phase:

- Medicines Manufacturing
- Audience of the Future
- Creative Industries Clusters
- Prospering from the Energy Revolution
- Industrial Decarbonisation
- Digital Security by Design
- Low Cost Nuclear
- Robotics for a Safer World
- Data to Early Diagnostics and Precision Medicine
- Commercialising Quantum Technologies
- Future Flight
- Faraday Battery
- Next Generation Services
- Transforming Construction
- Smart Sustainable Plastic Packaging
- Transforming Foundation Industries
- Transforming Food Production

Baseline reports for the following Challenges will be reviewed later and findings added as an addendum to this report:

- Healthy Ageing
- Accelerating Detection of Disease
- Driving the Electric Revolution

- Manufacturing Made Smarter

Annex B. Baseline workshop agendas

This annex presents the agendas for the five baselining workshops held September and October 2021.

B.1. Workshop on health and healthcare

Time	Session	Key areas for discussion
0900-0925	Welcome, introduction to the evaluation, Q&A	
0925-0950	Breakout session1: Knowledge creation and innovation in health and healthcare R&I at baseline (2018)	• How far were new health and healthcare innovations being adopted into practice in and before 2018? • How widespread was awareness and understanding of new developments and innovations? • How engaged were policymakers in addressing issues relevant to the ISCF Challenge areas?
0950-1000	Sharing observations in plenary	
1000-1030	Breakout session 2: Capacity and investment in health and healthcare R&I at baseline (2018)	• How risky was investment in health and healthcare R&I in and before 2018, and how did prior models of support effectively 'de-risk' investment? • To what extent was the necessary infrastructure in place to support R&I? • What was the level of talent and skills in UK R&I? • What were the key challenges relating to equality, diversity and inclusion in UK R&I? • How far were new businesses and high-skilled jobs being created and supported?
1030-1045	Sharing observations in plenary	
1045-1100	Comfort break	
1100-1130	Breakout session 3: Networks and collaboration in health and healthcare R&I at baseline (2018)	• How collaborative was R&I in health and healthcare in and before 2018? • What networks and collaborations were in place between businesses, and between business and academia? • To what extent were the UK and relevant UK businesses and institutions considered leaders in this field?
1130-1145	Sharing observations in plenary	
1145-1205	Breakout 4: Key barriers and enablers to the ISCF delivering intended outcomes and impacts, including key influencing factors	• Looking forward, what do you see as the main barriers to the ISCF achieving progress in the health and healthcare sector? • What are the main facilitators? • What other ongoing trends and initiatives might influence the intended outcomes and impacts of the Fund?
1205-1225	Concluding plenary discussion on the role of the ISCF within the UK R&I landscape	
1225-1230	Thanks and close	

B.2. Workshop on IT and data

Time	Session	Key areas for discussion
0900-0925	Welcome, introduction to the evaluation, Q&A	
0925-0950	Breakout session 1: Knowledge creation and innovation in UK R&I at baseline (2018)	• How far were new innovations being adopted into practice in and before 2018? • How widespread was awareness and understanding of new developments and innovations? • How engaged were policymakers in addressing issues relevant to the ISCF Challenge areas?
0950-1000	Sharing observations in plenary	
1000-1030	Breakout session 2: Capacity and investment in UK R&I at baseline (2018)	• How risky was investment in R&I in and before 2018, and how did prior models of support effectively 'de-risk' investment? • To what extent was the necessary infrastructure in place to support R&I? • What was the level of talent and skills in UK R&I? • What were the key challenges relating to equality, diversity and inclusion in UK R&I? • How far were new businesses and high-skilled jobs being created and supported?
1030-1045	Sharing observations in plenary	
1045-1100	Comfort break	
1100-1130	Breakout session 3: Networks and collaboration in UK R&I at baseline (2018)	• How collaborative was R&I in and before 2018? • What networks and collaborations were in place between businesses, and between business and academia? • To what extent were the UK and relevant UK businesses and institutions considered leaders in this field?
1130-1145	Sharing observations in plenary	
1145-1205	Breakout 4: Key barriers and enablers to the ISCF delivering intended outcomes and impacts, including key influencing factors	• Looking forward, what do you see as the main barriers to the ISCF achieving progress? • What are the main facilitators? • What other ongoing trends and initiatives might influence the intended outcomes and impacts of the Fund?
1205-1225	Concluding plenary discussion on the role of the ISCF within the UK R&I landscape	
1225-1230	Thanks and close	

B.3. Workshop on energy

Time	Session	Key areas for discussion
1400-1425	Welcome, introduction to the evaluation, Q&A	
1425-1450	Breakout session 1: Knowledge creation and innovation in UK energy R&I at baseline (2018)	• How far were new energy innovations being adopted into practice in and before 2018? • How widespread was awareness and understanding of new developments and innovations? • How engaged were policymakers in addressing issues relevant to the ISCF Challenge areas?
1450-1500	Sharing observations in plenary	
1500-1530	Breakout session 2: Capacity and investment in UK energy R&I at baseline (2018)	• How risky was investment in energy R&I in and before 2018, and how did prior models of support effectively 'de-risk' investment? • To what extent was the necessary infrastructure in place to support UK energy R&I? • What was the level of talent and skills in UK energy R&I? • What were the key challenges relating to equality, diversity and inclusion in UK energy R&I? • How far were new businesses and high-skilled jobs being created and supported?
1530-1545	Sharing observations in plenary	
1545-1600	Comfort break	
1600-1630	Breakout session 3: Networks and collaboration in UK energy R&I at baseline (2018)	• How collaborative was R&I in energy in and before 2018? • What networks and collaborations were in place between businesses, and between business and academia? • To what extent were the UK and relevant UK businesses and institutions considered leaders in this field?
1630-1645	Sharing observations in plenary	
1645-1705	Breakout 4: Key barriers and enablers to the ISCF delivering intended outcomes and impacts, including key influencing factors	• Looking forward, what do you see as the main barriers to the ISCF achieving progress in the energy sector? • What are the main facilitators? • What other ongoing trends and initiatives might influence the intended outcomes and impacts of the Fund?
1705-1725	Concluding plenary discussion on the role of the ISCF within the UK R&I landscape	
1725-1730	Thanks and close	

B.4. Workshop on transport and space

Time	Session	**Key areas for discussion**
1400-1425	Welcome, introduction to the evaluation, Q&A	
1425-1450	Breakout session 1: Knowledge creation and innovation in UK transport and space R&I at baseline (2018)	• How far were new innovations in transport and space being adopted into practice in and before 2018? • How widespread was awareness and understanding of new developments and innovations? • How engaged were policymakers in addressing issues relevant to the ISCF Challenge areas?
1450-1500	Sharing observations in plenary	
1500-1530	Breakout session 2: Capacity and investment in UK transport and space R&I at baseline (2018)	• How risky was investment in transport and space R&I in and before 2018, and how did prior models of support effectively 'de-risk' investment? • To what extent was the necessary infrastructure in place to support UK transport and space R&I? • What was the level of talent and skills in transport and space R&I? • What were the key challenges relating to equality, diversity and inclusion in transport and space R&I? • How far were new businesses and high-skilled jobs being created and supported?
1530-1545	Sharing observations in plenary	
1545-1600	Comfort break	
1600-1620	Breakout session 3: Networks and collaboration in UK R&I at baseline (2018)	• How collaborative was R&I in transport and space before 2018? • What networks and collaborations were in place between businesses, and between business and academia? • To what extent were the UK and relevant UK businesses and institutions considered leaders in this field?
1620-1630	Sharing observations in plenary	
1630-1650	Breakout 4: Key barriers and enablers to the ISCF delivering intended outcomes and impacts, including key influencing factors	• Looking forward, what do you see as the main barriers to the ISCF achieving progress in the transport and space sector? • What are the main facilitators? • What other ongoing trends and initiatives might influence the intended outcomes and impacts of the Fund?
1650-1715	Concluding plenary discussion on the role of the ISCF within the UK R&I landscape	
1715-1730	Thanks and close	

B.5. Workshop on manufacturing and sustainability

Time	Session	Key areas for discussion
0900-0925	Welcome, introduction to the evaluation, Q&A	
0925-0950	Breakout session 1: Knowledge creation and innovation in UK manufacturing and sustainability R&I at baseline (2018)	• How far were new innovations in manufacturing and sustainability being adopted into practice in and before 2018? • How widespread was awareness and understanding of new developments and innovations? • How engaged were policymakers in addressing issues relevant to the ISCF Challenge areas?
0950-1000	Sharing observations in plenary	
1000-1030	Breakout session 2: Capacity and investment in UK manufacturing and sustainability R&I at baseline (2018)	• How risky was investment in manufacturing and sustainability R&I in and before 2018, and how did prior models of support effectively 'de-risk' investment? • To what extent was the necessary infrastructure in place to support R&I? • What was the level of talent and skills in R&I? • What were the key challenges relating to equality, diversity and inclusion in R&I? • How far were new businesses and high-skilled jobs being created and supported?
1030-1045	Sharing observations in plenary	
1045-1100	Comfort break	
1100-1120	Breakout session 3: Networks and collaboration in UK R&I at baseline (2018)	• How collaborative was R&I in manufacturing and sustainability before 2018? • What networks and collaborations were in place between businesses and between business and academia? • To what extent were the UK and relevant UK businesses and institutions considered leaders in this field?
1120-1130	Sharing observations in plenary	
1130-1150	Breakout 4: Key barriers and enablers to the ISCF delivering intended outcomes and impacts, including key influencing factors	• Looking forward, what do you see as the main barriers to the ISCF achieving progress in the manufacturing and sustainability sector? • What are the main facilitators? • What other ongoing trends and initiatives might influence the intended outcomes and impacts of the Fund?
1150-1215	Concluding plenary discussion on the role of the ISCF within the UK R&I landscape	
1215-1230	Thanks and close	

Annex C. Implications of the preliminary network analysis for later phases of the evaluation

The preliminary network analysis set out above provides some interesting initial insights into the structure of collaboration across ISCF Challenges. The analysis demonstrates that we can use data on event attendance and collaborative project funding to visualise and quantitatively analyse the nature of potential or actual collaborative networks supported by ISCF funding. However, given the current early stage of the ISCF and the limitations of the data mentioned above, these findings should be viewed as preliminary and with a degree of caution. In particular, we note that while we can include academic institutions in the analysis, a lack of detail on the individual academics or departments engaged means we are less confident about the validity of analysis which includes them, and suggest focusing the analysis on private and third-sector organisations instead.

That said, a network analysis approach based on the available ISCF data appears to be a promising method for evaluating the structure of collaborative activity across ISCF Challenges. If a similar analysis were repeated at a later stage in the ISCF evaluation, this may provide more robust findings based on more (and more complete) data, as well as offering a basis for triangulation with wider evaluation evidence.

There are also several ways this analysis could be extended in future that may provide additional useful insights. For example:

- It may be possible to conduct a dynamic analysis exploring how the network of collaboration evolves over time, for example by comparing the networks with these baseline findings, and/or limiting the data to events and funded projects which were undertaken at different points in time.
- Further analysis could be undertaken looking at the 'local' network of each individual Challenge in more detail and exploring the key connections between them.
- It may also be informative to combine the KTN and Delphi data. For example, one could include both types of connections (mutual event attendance and project collaboration) in a single network, though as noted earlier, we would need to define a (potentially arbitrary) way to weight project collaboration and event attendance. Any results would therefore need some sensitivity testing to the choice of this method.
- Another potential use of matching the KTN and Delphi data would be to look at whether mutual event attendance is predictive of organisations subsequently collaborating formally on a project. However, it should be noted that matching the data is somewhat difficult given the organisation

identifiers available and, as noted earlier, there is relatively limited overlap between the two, at least based on the preliminary assessment made for this baseline report.

- Finally, we may also explore using the Delphi data to analyse the geographic distribution of beneficiaries funded through the ISCF, though recognising that this covers only a particular form of support through the Fund (funded collaborative projects) and that geographic data on other forms of engagement is more limited.

Annex D. Econometric analysis scoping

D.1. Aims

The evaluation framework report included a detailed account of proposed econometric analysis to be conducted as part of the impact evaluation, focusing on how the ISCF has generated economic benefits for businesses supported by one or more Challenges. During the baseline phase, Frontier conducted further scoping analysis, in particular to better understand the nature of *treatment data* that may be available from different sources. This Annex reports the findings of this scoping and considers implications for the econometric approach proposed in the Framework.

Econometric analysis will be conducted to understand the impact of the Fund on business performance. The approach will use data-linking to compare how businesses engaged by the Fund (the 'treatment group') perform compared with an objective counterfactual ('control group') of observationally similar businesses. Outcomes will include key business performance indicators such as headcount employment, business turnover, business survival and a proxy for productivity (turnover per worker). This will give an indication of whether businesses grew quicker than they would have without the support, or were less likely to fail.

Rather than explore impacts at the Challenge level, the econometric analysis will seek to explore the impact of the ISCF as a whole (and potentially at other levels of disaggregation such as the Grand Challenges). This will form a key input into the economic evaluation feeding into the 'growth of UK businesses' and 'increased productivity' parts of the logic model. As well as corresponding to its mission-oriented structure, a key motivation for conducting the analysis at the wider ISCF level is that organisations may interact with multiple Challenges, which means attribution of impact is difficult in respect of a single Challenge in isolation. A further advantage is that pooling the data across multiple Challenges gives larger sample sizes and more reliable estimates of an average treatment effect.

D.2. Analytical approach

We propose to draw on a combination of Propensity Score Matching (PSM) and Difference-in-Difference (DiD) analysis approaches to estimating impacts. Both are **quasi-experimental** methods commonly used in conducting evaluations, where the control group acts as a counterfactual for how supported businesses would have performed in the absence of ISCF support.

Rather than receiving support at random, businesses select into applying for support. This means that supported firms are likely to differ systematically from non-supported businesses, so that simply looking at outcomes for non-supported businesses is unlikely to provide a robust counterfactual. This problem is addressed by using PSM. The approach uses a first-stage regression model to estimate the likelihood of treatment ('propensity score'), which is then used to find, for each treated firm, a group of non-treated firms with similar likelihood of treatment based on observable characteristics. The additional use of DiD can further 'difference out' any pre-treatment differences between the treatment and control groups in terms of key metrics of interest, assuming that these metrics follow similar pre-treatment trends for the two groups.[364]

D.3. Data sources

The econometric analysis will be done using a linked dataset, containing administrative data on outcomes and business characteristics, together with data from the ISCF on which businesses were supported. The data will be linked using the Companies House reference number (CRN), a unique company identifier.

In terms of outcome metrics, we propose to use the Business Structure Database (BSD), which is a snapshot of the Inter-Departmental Business Register (IDBR). The BSD covers all businesses that are registered for either VAT or PAYE, thus having very extensive coverage, with around 2.6 m firms included per year. It follows firms over time and is updated with turnover and employment data sourced from HMRC. From this can be derived outcomes in terms of employment, turnover, turnover per worker and survival. It therefore has the longitudinal structure needed for the PSM and DiD techniques that will be implemented. It also contains data on foreign ownership, industrial sector, location and age, which can be used as control variables (alongside the turnover and employment size metrics, and potentially historical growth trajectories of these variables).

A key advantage of the BSD's virtually exhaustive coverage is that unless treated firms are very small (i.e. below VAT and PAYE registration thresholds), they will appear in this dataset, as will a large number of potential comparators. This maximises the sample sizes available, increasing the robustness of the analysis, and making various types of disaggregation of the analysis feasible. By contrast, many of the other business datasets considered for use lacked either the longitudinal structure, completeness or sample sizes needed (see the Evaluation Framework Report for details).

In terms of characterising business support, the picture is more nuanced, as firms may interact with Challenges in different ways and the data characterising this is captured in multiple datasets. An important part of the baselining phase was therefore to collect and analyse the different business support datasets, to inform which analyses should be feasible once the evaluation takes place. This involved reviewing the coverage and completeness of the variables included in the data, the extent of overlap between different types of support, and how easily they can be linked to the business data, or to specific Challenges. This is assessed in detail in the following section, with a brief description of the datasets below:

- *Delphi* is a central UKRI dataset largely populated from the Innovation Funding Service Post Award (IFS-PA). It contains data on all funded projects, with unique identifiers for the projects and organisations involved. Organisation-level data include participant type, size and location.

[364] In principle, the PSM process should lead to the treatment and control groups being observably identical in terms of e.g. pre-treatment levels of employment or turnover. In practice, there may be some differences remaining between the groups. See Frontier Economics (2017), 'The Impact of Public Support for Innovation on Firm Outcomes, BEIS Research Paper 3' (available here).

Project-level data include the Challenge, programme and competition it falls within; application number and awarding date; the project (name and identifier), start and end date, grant amounts, costs and grant claimed to date by awardee. The CRN identifier provides a way to link organisations in Delphi to their respective entries in the BSD, and the funding dates and Challenge field clearly allow supported firms and the supporting entity to be defined and the period of support to be identified. This is provided across the range of Challenges and the Delphi-BSD provides the most straightforward frame in terms of defining an analytical dataset.

We have already been provided with and analysed the Delphi dataset in its current form. An updated version would be needed at the point at which the evaluation takes place.

- *Knowledge Transfer Network*. Established by IUK, KTN is a central hub for connecting innovators and running events that bring together people, companies, government agencies, universities and research organisations. Challenges have events run through the KTN, and attendance data is generated through the CRM software. Data includes the organisation and event name and identifier, enabling us to identify organisations that have interacted with Challenges through attending events, providing another potential measure of support.[365] More generally, this gives a rich overview of the interaction of firms attending Challenge-run events. This is explored further in the 'Connected Innovation Ecosystem' section in the main body of the report.

  We have already been provided with and analysed the KTN dataset in its current form. An updated version would be needed at the point at which the evaluation takes place.

- *Innovation Funding Service*. This dataset contains applications for grant funding. This provides information on unsuccessful applicants, who could be used as an alternative counterfactual group. However, our understanding is that data in IFS is in many cases incomplete, in particular with CRNs often missing. This would necessitate fuzzy matching on name and location, but if this is not accurate, there is a risk of identifying the 'wrong' business as a counterfactual, which would present difficulties.

  We are currently investigating data access arrangements for IFS data.

- *Challenge-level data*. We also considered the possibility that Challenges may interact directly with organisations in ways that do not appear in the Delphi, IFS or KTN datasets. For example, they may run competitions outside the ISCF system, run events independently, or provide other types of support. We wanted to gauge the extent of this, so engaged with Challenges directly using a data request template. This is described in further detail below in section D.5.1 A very high-level summary is that most of the support data are indeed collected through central databases such as Delphi, IFS and KTN described above, and that relatively few Challenges hold significant additional data that would be desirable to incorporate in the main analysis.

[365] Note that organisation identifiers are internal to KTN and do not map directly to CRNs. Linking to the BSD data outcomes data can therefore only be done through business name, which is less accurate than the CRN. To do this we propose to use the 'ONS IDBR marching service', who can use fuzzy matching on name and location to derive CRNs, and thus enable linking to the administrative data.

D.4. Review of Delphi and KTN

This section contains further discussion of Delphi and KTN, to help inform the scoping of the econometric analysis.

Delphi

The extract we were provided with contains 3,752 observations overall, where each observation is a participant in an ISCF project. Participants may be in multiple projects and a project may have multiple participants. The dataset contained details of projects starting from 1st June 2017 to 1st June 2021.

We first focused on the completeness of the CRN data in Delphi, as this is of crucial importance in reliably linking the data to business data. CRNs were included for 2,895 observations, around three quarters. Of those observations missing CRNs, 711 had keywords within the organisation name to suggest it is not a company.[366] This would mean they are excluded from the scope of the econometric analysis. This left only 146 remaining observations without a CRN.

The 3,752 observations relate to 2,171 unique participants, as some are involved in multiple projects. Among this group, 1,827 have CRNs, 216 lack CRNs but appear not to be companies and 128 appear to be companies with missing CRNs. This suggests we have CRN information for at least 94 per cent of unique companies in the dataset (the figure could be higher if some of the 128 are not companies), which is high.

The data are complete in terms of linking to Challenges and providing start and end dates for the support. In a small number of cases, the amount of grant offered is missing or zero. The 71 cases from which it is missing are projects that were withdrawn after approval. The 293 cases where the grant offered is zero are all projects with multiple participants, one of which *has* received a positive grant amount, so some participants are not directly funded.

Delphi contains several additional variables such as sector, size band, organisation type and lead organisation. While these are largely complete, it should be noted that by definition they will not exist for non-funded organisations, so cannot be used as control variables. In any case, with the exception of 'lead organisation', the other variables should largely be captured in the BSD, so it is not necessary to draw that information from Delphi.

KTN

KTN data is generated through attendees registering for and attending events. The file we analysed contained 25,257 entries, where an observation is an individual (pseudonymised and linked to an organisation) registered for an event. It covers 260 events, running from August 2017 to July 2021.

The events are not directly linked to Challenges, but the names of the Challenges often appear in the event name. This allowed us to use keyword searches to link to Challenge. This process led to 158 events matched to a Challenge, and 102 unmatched. The remaining cases required manual matching (e.g. 'battery' would indicate a link to the Faraday Battery Challenge) which enabled a further 57 matches of reasonable quality

[366] This is using the following keywords: univ, college, school, centre, catapult, nhs, institute, borough, authority, council.

and 45 cases where we were not confident which Challenge an event belonged to. Given the relatively small number of events, a more intensive manual matching would be feasible, including a validation process with Challenges and UKRI.

KTN contains data on attendees from 4,424 organisations. Because information on attendees and organisations is captured as it is entered into registration systems, there is no link to CRNs, and instead fuzzy matching must be used. This presents problems for linking KTN to the BSD, as we may link to the 'wrong' business. Moreover, the lack of geographic address is problematic, as this is used in performing the fuzzy match and assessing its accuracy. We therefore note the potential for errors in linking the KTN database to BSD, though have not so far been able to validate with ONS whether fuzzy matching based entirely on company name is feasible.

We assessed the overlap between KTN and Delphi by standardising the text of the organisation name fields in both datasets.[367] This resulted in only 652 of the 4,424 organisations in KTN finding a match in Delphi. A more formal fuzzy matching procedure using Stata software returned very few additional matches. Manual examination of a selection of these unmatched cases suggested that this was a genuine lack of overlap between the datasets, rather than a failure to match entities that were genuinely the same.

On this basis we would conclude that only a small proportion of event attendees have participated in projects funded and recorded in Delphi (652 of 4,424), and likewise, that only a small proportion of awardees have attended events run by KTN (652 of 2,171). This finding was somewhat surprising, but it would indicate that the grant funding and event attendees are relatively distinct groups. This has implications for how different treatment subgroups may be defined, with an obvious first delineation being 1) grant awardees, 2) event attendees and 3) the overlap group.

The overall breakdown of grant-awarded projects and organisations and KTN events is shown below. This shows most Challenges being present in both datasets, although some have fairly low numbers of events despite funding many projects and organisations. This may explain some of the lack of overlap between which organisations are included in the respective datasets.

Table 14: Numbers of grant awardee projects and KTN events by Challenge

Challenge	Delphi projects	Delphi organisations	KTN events
Accelerating Detection of Disease	1	1	0
Audience of the Future	73	133	28
Commercialising Quantum Wave 3	39	118	9
Creative Industries Clusters	0	0	0
Data To Early Diagnosis and Prevention	41	140	10
Digital Security by Design	25	24	7
Driving the Electric Revolution	44	88	5
Faraday Battery Challenge	78	148	18
Future Flight	50	148	12
Healthy Ageing	40	54	19
Industrial Decarbonisation	25	102	6
Low Cost Nuclear (phase 1)	1	9	0

[367] This is done by converting to lower case, removing multiple spaces, extraneous characters such as '.' or '&' and text such as 'plc' or 'limited'.

Manufacturing Made Smarter	55	183	14
Medicines Manufacturing	190	342	6
Next Generation Services	51	107	11
Prospering From the Energy Revolution	81	232	1
Quantum Technologies Wave 2	4	37	16
Robotics for a Safer World	145	211	1
Smart Sustainable Plastic Packaging	31	51	3
Transforming Construction	67	209	13
Transforming Food Production	100	235	12
Transforming Foundation Industries	38	94	17

D.5. Challenge-level data

This section outlines the process the process for engaging with Challenges and summarises the overall findings.

D.5.1. Process for engaging with Challenges

An Excel-based data template was developed and sent out to each Challenge. These were directed at the Challenge-level evaluation leads, based on a contact list provided by UKRI. The requests were made in August 2021, with further reminder emails in September to obtain responses.

The data template requested information about the contact lists or databases held within the Challenge about the organisations engaged, the type of information held and the completeness of the records. More specifically, it requested data around availability and completeness of the following data:

- Company name, address and CRN fields
- Any business demographic data
- Information on the type and value of support provided, and start and end dates
- Details to identify academic and third sector organisations;
- Contact information for the key contact point within the respective organisations
- Numbers of successful and non-successful applicants

D.5.2. Summary of findings from Challenge-level data request

In total, detailed template responses were received from 19 of the 22 Challenges.[368]

Challenge-level data

Regarding the use of Challenge-level as opposed to central data, we found that a large majority of Challenges reporting using centrally held datasets, with Delphi cited in nine cases and IFS in 12. In other cases, there

[368] Of the other three Challenges, Low Cost Nuclear gave a detailed response outside the template, owing to its different circumstances covering only one specific project, while Medicines Manufacturing and Manufacturing Made Smarter were unable to respond at the time due to resourcing constraints.

was reference to the UKRI/IUK data warehouse, central databases or multiple databases. The only areas where centrally held data was *not* mentioned were:

- Creative Industries Clusters refers to having data on higher education institutions through Siebel/Salesforce and fragmented internal data on indirect beneficiaries
- Next Generation Services – the Singapore Global Business Innovation Mission 2019 uses a Challenge-held spreadsheet on beneficiaries
- Transforming Construction – the Active Building Centre stream holds data in a CRM. This activity is due to conclude by September 2022, so full information should be available in due course

The other cases where Challenge-level data sources were reported were:

- Prospering from the Energy Revolution – the EnergyRev has a project database on higher education institutions. This work is due to conclude by March 2023
- Transforming Foundation Industries references a TFI Team database, alongside IFS and KTN
- Future Flight references a TIBCO database, alongside IFS and Delphi

Business demographics

The Challenges reported holding very little data on business demographics. The data are either described as incomplete or are confined to a very limited set of basic characteristics that are already captured in the central datasets. Therefore, additional data on business demographics are unlikely to be available.

Description of support

Where Challenges report holding support data at the business level, this relates overwhelmingly to grant funding, which is already captured in the central datasets. Several Challenges also gave general descriptions of wider (i.e. non-financial) support activities carried out, but there was no indication that there would be any systematic data showing which recipients received specific types of non-financial support. As a result, we consider that while it will be useful to attempt to supplement the Delphi and KTN databases with other support data from a limited number of Challenges as set out above, we may only be able to define binary (0/1) treatment indicators from these additional Challenge-specific databases, rather than more granular definitions of support type.

Unsuccessful applicants

Around half of Challenges reported that data on unsuccessful applicants would be available. Where data sources were described, this referred back to IFS or to central datasets (which we interpret as referring to IFS). On this basis, we conclude that Challenge-level data on unsuccessful applicants, above and beyond what is captured in IFS, is unlikely to be available for the evaluation. The only exceptions to this are data on unsuccessful higher education institutions in the following cases:

- Creative Industries Clusters (where it is held in Siebel/Salesforce)
- Digital Security by Design, where data are reportedly held by the EPSRC

Finally, it is interesting to note that the ratio of successful to unsuccessful applicants varies significantly across Challenges. Overall, a typical pass rate is in the region of 50–60 per cent, but some are very low (e.g.

Next Generation Services has 75 successful/400 unsuccessful; Smart Sustainable Plastic Packaging has 74 successful/695 unsuccessful) whereas the Industrial Decarbonisation Challenge has 89 successful/9 unsuccessful. This is relevant when considering the appropriateness of using unsuccessful applicants as a counterfactual, as significant variation could present difficulties for using it in a cross-Challenge context.

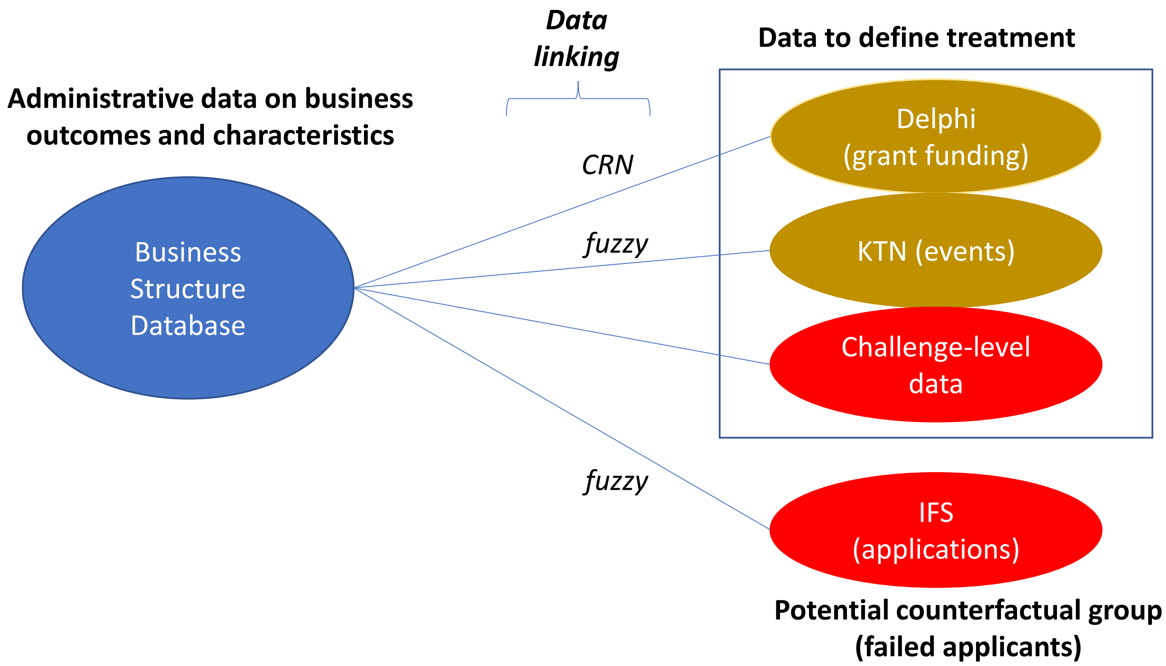
D.6. Implications for econometric analysis

The review of data sources in the baselining phase has largely reinforced the approach set out in the Evaluation Framework report.

- The longitudinal structure, virtually exhaustive coverage, and completeness of variables support using the Business Structure Database as the data source for business outcomes and characteristics. Other datasets bring significant difficulties in terms of incomplete coverage, which would affect the clarity of analysis.
- Delphi and KTN capture a large majority of data available around which organisations have been supported, and together can be used to define the treatment group.
    - In practical terms, it is straightforward to link Delphi with the BSD, as CRNs for businesses are largely complete.
    - KTN requires both fuzzy matching on names to link with the BSD, and manually identifying which Challenge an event belongs to. Both these steps are prone to error, which reduces the accuracy of any estimated effect, and may make detection of an effect more difficult, particularly given that event attendance may be considered a more 'light touch' form of support than grant funding.
- IFS data on unsuccessful applications would also require fuzzy matching on name, and poor match quality would be problematic for the purposes of defining a counterfactual as we may be comparing with the 'wrong' businesses. Large variations in pass rates between Challenges could also present difficulties, calling into question how feasible this data is for defining a counterfactual. We therefore would not propose to use unsuccessful applicants as a control group, instead drawing the controls from the wider business population contained in the BSD.
- Challenge-level data is likely to be useful only in a limited number of cases, as the measurable data are largely captured in Delphi and KTN.
- The low overlap between event attendance and grant funding means these types of support can be assessed quite distinctly from each other, both in terms of econometric and network analysis.

The overall proposed structure of the dataset is shown in Figure 49 below.

Figure 49: Proposed structure of analytical dataset



Note: Challenge-level and IFS data are shaded in red to indicate uncertainty as to how far they can be used in the analytical dataset.

Annex E. Evaluation baseline table

This annex presents an evaluation baseline table. The table maps baseline findings to the ISCF Fund-level evaluation framework. The first three columns of the table map evaluation themes and evaluation questions to key baseline messages. The fourth and fifth columns map detailed baseline findings to specific evaluation indicators as set out in the evaluation framework. As has been noted elsewhere in this report (Section 2.5), owing in large part to variability of the baseline data collected by individual Challenge-level evaluations, in many cases it has not been possible to quantitatively baseline evaluation indicators. As such, the detailed baseline findings mapped to evaluation indicators within the table do not provide specific quantitative baseline measures against which to compare later impact evaluation findings. In mapping detailed baseline findings to evaluation indicators, we have adopted a flexible approach; where baseline findings have relevance to an evaluation indicator, these have been included in the table even if the baseline data does not provide a robust quantitative baseline measure for that indicator. There are some instances in which an indicator has no associated baseline findings due to either the nature of the indicator or availability of appropriate Fund- or Challenge-level data.

Impact evaluation theme	Impact evaluation question	Key baseline message	Evaluation indicator	Detailed baseline finding(s)
Creating knowledge and innovation pathways	To what extent has the ISCF advanced the readiness of new technologies, products and processes?	New technologies and innovations were already being developed in many Challenge areas at baseline but faced consistent challenges to implementation and adoption at scale.	Evidence of patent licensing agreements and coverage across Challenges[369]	• Data from Challenge-level baseline reports showed that the UK had a strong track record of patenting within several Challenge areas at baseline, including Data to Early Diagnosis and Precision Medicine, Medicines Manufacturing, Robotics for a Safer World, Quantum Technologies and Faraday Battery. • Where data on the baseline patent activity of Challenge applicants or participants was captured by Challenge-level baseline reports, on average of somewhere between a quarter and a third of respondents had applied for IP relating to their ISCF projects.
			Evidence of movement across TRLs/Commercial Readiness Levels (CRLs)	• Data from Challenge-level baseline reports indicated that in most cases, ISCF-funded projects were at relatively early stage of readiness at baseline, with most projects reporting TRLs of 1 to 4. Within individual Challenges, TRLs often varied across different funding streams.
	To what extent have ISCF outputs (technologies, products, processes, services, approaches, etc.) been	New technologies and innovations were already being developed in many Challenge areas at baseline but faced consistent challenges to	Evidence of other measures of IP (e.g. trademark, registered	• N/A

[369] Indicator refers broadly to 'evidence of', given the possibility that Researchfish and PCFs may not produce reliable data on a specific number of outputs but will likely produce useful evidence to support the evaluation. The specific evidence presented for this indicator will be refined in phase 4 of the evaluation based on data completeness, quality and availability.

	implemented/adopted within society?	implementation and adoption at scale.	design, copyright) and coverage across Challenges[370]	
			Evidence on number and nature of examples of adoption reported (on aggregate and by Challenge)	• N/A
			Examples of implementation and adoption of outputs in context	• Data from the UK Innovation Survey suggested varying levels of 'innovation activity' by sector, with high levels of activity among businesses within research and experimental development on social sciences and humanities, computing and ICT, and manufacture of transport equipment. Other Challenge-relevant sectors with high levels of innovation activity included architectural and engineering activities and various types of manufacturing, including of fuels, chemicals, food and paper. • Data from Challenge-level baseline reports showed that in some Challenge areas, including Audience of the Future, Data to Early Diagnosis and Transforming Foundation Industries, there was evidence that new or improved products and services were being developed at baseline. • Data from Challenge-level baseline reports showed that new business models were being established in some Challenge

[370] Indicator refers broadly to 'evidence of', given the possibility that Researchfish and PCF forms may not produce reliable data on specific number of outputs but will likely produce useful evidence to support the evaluation. The specific evidence presented for this indicator will be refined in phase 4 of the evaluation based on data completeness, quality and availability.

				areas at baseline. Relevant Challenge areas included Audience of the Future and Next Generation Services.
			Stakeholder perceptions on the extent of adoption and role of the ISCF	• Data from Challenge-level baseline reports and baselining workshops showed that there were wide-ranging barriers to the scale-up of new technologies and innovations at baseline, including many barriers common across different Challenge areas. Key themes highlighted included barriers relating to: the maturity of key enabling technologies; policy, regulatory and standards frameworks; existing business models; stakeholder awareness; costs and investment; data access and security; fragmentation; and training and skills.
	What has been the contribution of the ISCF to new knowledge addressing the Challenges, both within the UK and internationally?	The UK has a strong track record in terms of publications output and quality, which was reflected in several Challenge areas at baseline. At the same time, there were some Challenge areas in which publications output was low, or where publications were not a focus.	Number of publications and coverage across Challenges	• According to Scopus data, the UK had a strong publications track record relative to the country's size and scale of R&D investment. In 2018, the UK published 212,876 publications, equating to 7 per cent of the total world publications output. UK publications were also highly cited, with the UK recording the highest FWCI among G7 and other comparator countries, a position it has held since 2007. • For Challenges for which we were able conduct bibliometric analysis, the performance at baseline was strong, with normalised citation impacts and proportion of highly cited publications well above world average and also above the UK average. The average Field Citation Ratio at baseline across the Fund was 4.32, with 18% of prior articles in the top 5% most highly cited articles. • Data from Challenge-level baseline reports showed that the UK's strong track record in terms of publications output and quality was reflected in several Challenge areas at baseline, including Robotics for a Safer World, Industrial Decarbonisation, Faraday Batter and Quantum Technologies.

			Evidence of other (non-publication) outputs by type (e.g. software, datasets, tools) and by Challenge[371]	• N/A
	To what extent has the ISCF leveraged knowledge and insights to create increased awareness and understanding among key stakeholders of new technologies and outputs addressing the Challenges?	There were gaps in awareness and engagement of policy, industry and wider public stakeholders at baseline, though the extent of these gaps varied across Challenge areas.	Examples of engagement activities that have led to increased awareness and understanding of stakeholders	• N/A
			Stakeholder perceptions on the awareness and understanding of key stakeholders and the influence of ISCF-funded activities	• Data from Challenge-level baseline reports and baselining workshops showed that there was general awareness of R&I opportunities within the Challenge areas among policymakers at baseline. However, in many cases, awareness of the specific needs of the Challenges was low, with significant gaps in policymakers' understanding and engagement. • Looking at publications by ISCF award holders prior to award (2014–2018) across the Fund, 4.7% of these were cited in policy documents. The level varies between Challenges, with some areas – notably Prospering from the Energy Revolution, Data to Early Diagnosis and Precision Medicine, and Industrial Decarbonisation – having higher proportions of their publications cited in policy documents. • Data from Challenge-level baseline reports and baselining workshops showed that awareness of businesses regarding R&I opportunities within the Challenge areas was varied at baseline, with gaps in some areas, e.g. CCUS.

[371] Indicator refers broadly to 'evidence of', given the possibility that Researchfish and PCFs may not produce reliable data on a specific number of outputs but will likely produce useful evidence to support the evaluation. The specific evidence presented for this indicator will be refined in phase 4 of the evaluation based on data completeness, quality and availability.

				• Data from Challenge-level baseline reports and baselining workshops showed a general lack of public awareness of R&I across Challenge areas. • Evidence from scientometric analysis suggests that there was wider communication of outcomes of research prior to the programme based on Altmetric data. Over half of prior publications (in the period 2014–2018) of award holders had some Altmetrics associated with them. The average Altmetric score for the baseline set as a whole is 31.20. There was also some significant variation by Challenge area, though we note a low number of publications were matched for some Challenges so in those cases the data should be interpreted with caution.
	To what extent has the ISCF contributed to evidence-based policymaking surrounding the Challenges?	Across Challenge areas, existing policy landscapes presented barriers to the advancement and scale-up of technologies and innovations at baseline.	Examples of engagements with policy stakeholders that have contributed to evidence-based policymaking	• N/A
			Perceptions of policy stakeholders (and others) on the extent and nature of the ISCF's contribution of to evidence-based policymaking	• Data from Challenge-level baseline reports and baselining workshops showed that, across Challenge areas, existing policy landscapes presented obstacles to the advancement and scale-up of technologies and innovations at baseline. Barriers posed included: difficulties experienced by companies operating across multiple jurisdictions; the slow pace of regulation compared to technological change; lack of coordination between policy actors; lack of policy pressure for change; tensions between privacy regulations and data collection and exchange activities; inertia of existing policy frameworks; regulatory uncertainty; and a lack of standardisation.

	To what extent has the ISCF enhanced understanding of the effectiveness of mission-oriented R&I programmes and informed more effective policymaking for mission-oriented goals?	Not addressed at baseline stage	Perceptions of key stakeholders on the nature and extent of learning from the ISCF on mission-oriented R&I	• N/A
			Examples of the influence of the ISCF on wider mission-oriented R&I activities identified by key stakeholders	• N/A
Capacity and investment	To what extent has the ISCF increased UK businesses' investment in R&D?	Firms in the UK had some experience funding and delivering R&D projects. However, there was considerable variation between sectors, with some sectors featuring high-performing and/or well-established firms with high levels of R&D expenditure.	Amount of business investment in R&D generated (on aggregate, by sector[372] and by Challenge)[373]	• ONS data showed that in 2018, UK businesses invested almost £26bn in R&D, but that levels of investment varied across sectors. Sectors with higher levels of expenditure included: pharmaceuticals, motor vehicles and parts, computer programming and information service activities, aerospace and software development. • Data from Challenge-level baseline reports showed that firms supported by the ISCF had some experience funding and delivering R&D projects prior to the ISCF, though evidence suggests that levels of investment varied across sectors. In some sectors, business R&D expenditure was concentrated within a small number of high-performing and/or well-established firms. This included sectors relevant to Industrial Decarbonisation, Future Flight, Medicines Manufacturing, Audience of the Future and Transforming Foundation Industries.

[372] Analysis of sector will likely rely on SIC code data, which may not reflect emergence of new sectors and may not align with the wider ISCF approach to defining sectors for the Challenges.

[373] This analysis will consider not just co-investment in the award but also from additional aligned and accompanying investments leveraged.

	To what extent has the ISCF increased overseas investment in R&D in the UK?	At baseline, there was evidence of overseas R&D investment in UK businesses across many sectors. Foreign direct investment was particularly important within certain Challenge areas, including the life sciences sector and for the chemicals, ceramics and metals sectors.	Stakeholder perceptions on the extent to which the ISCF has increased overseas investment in UK R&D	• ONS data shows that, in 2018, overseas investment in UK R&D totalled £5.0bn, with the largest proportion of this (£3.25bn) spent on R&D in business enterprises. There were variations in levels of overseas investment across sectors. Sectors with a high number of FDI projects at baseline included software and computer services, business and consumer services, financial services and environment, infrastructure and transportation.
	How much additional public and private R&D investment has the ISCF contributed towards the R&D investment target of 2.4% of GDP by 2027?	In 2018, overall expenditure on R&D in the UK was at £37.1bn, which represented 1.71% of GDP. Wider investment in UK R&D and businesses varied considerably between sectors. There was some public sector funding, but this lacked coordination and long-term focus. The third sector played an important role in funding medical R&D. Private sector investment in UK businesses varied due to differences in the size of different sectors.	Overall amount of investment in R&D generated (and measured against the 2.4% target)[374]	• ONS data showed that, in 2018, overall expenditure on R&D in the UK was at £37.1bn, which represented 1.71% of GDP. • Data from Challenge-level baseline reports and baselining workshops showed that UK government investment in R&D varied between Challenges at baseline, with evidence of increasing public investment in R&D in some Challenge areas, such as Faraday Battery and Transforming Food Production. The third sector played an important role in funding medical R&D. Private investment varied across sectors at baseline.
	To what extent has research supported by	At baseline, investment in R&I across several sectors	Evidence on the amount and source of investments in R&D	• Data from baselining workshops indicated that several sub-sectors within different Challenge areas were considered high-risk at baseline. These included sub-sectors AI for

[374] While we can measure the amount of investment enabled through the ISCF and compare it to the 2.4% target, it will not be possible to know how much of this investment is 'additional'. For example, private investment enabled through the ISCF may not be additional as such, but instead displace funding that would otherwise have happened.

	the ISCF opened up new avenues of investment (de-risking)?	was considered high-risk, with inadequate mechanisms to support investment, adoption and scale-up.	resulting from participation in ISCF projects[375]	healthcare, SMRs and battery technologies. Reasons for high-risk included lack of support mechanisms for accelerating innovation, adoption and scale-up. Some sectors, such as aerospace and CCUS had systemic support for R&I, which had helped to de-risk investment.
			Examples of ISCF research that has opened up new avenues of investment	• N/A
			Stakeholder perceptions on the extent to which ISCF Challenges have contributed to de-risking	• Data from baselining workshops indicated that several sub-sectors within different Challenge areas were considered high-risk at baseline. These included sub-sectors AI for healthcare, SMRs and battery technologies. Reasons for high-risk included lack of support mechanisms for accelerating innovation, adoption and scale-up. Some sectors such as aerospace and CCUS had systemic support for R&I, which had helped to de-risk investment.
	While the ISCF is place-agnostic, to what extent have the Fund's investment and activities been widely distributed across the UK?	At baseline, there were differences across the UK in terms of R&D expenditure, with an apparent concentration of investment in London and the South	Geographic spread of ISCF investment and activities (location of participants)	• ONS data showed that, in 2018, there were differences across the UK in terms of R&D expenditure. England had higher amounts of R&D spending (£33,039m) than Wales (£798m), Scotland (£2,712m) and Northern Ireland (£715m). Within England, there were also differences between regions, with higher R&D spending in the South East (£7,089m), East of England (£6,608m) and London (£5,970m) compared to other regions.[376]

[375] Indicator refers broadly to 'evidence of', given the possibility that Researchfish and PCF forms may not produce reliable data on specific number of outputs but will likely produce useful evidence to support the evaluation. The specific evidence presented for this indicator will be refined in phase 4 of the evaluation based on data completeness, quality and availability.

[376] While normalisation against country and regional population sizes would provide further insight on the equity of the distribution of R&D investment, the general picture would appear to be a concentration of R&D investment in England, and in particular within London and its surrounding areas, compared to the rest of the UK.

		East compared to the rest of the UK.		• Data on IUK R&D expenditure by region at baseline (2018–2019) demonstrates high levels of investment in the West Midlands, the South East, London and the South West.
			Stakeholder perception regarding the extent to which ISCF investment and activities have been widely spread	• ONS data showed that, in 2018, there were differences across the UK in terms of R&D expenditure. England had higher amounts of R&D spending (£33,039m) than Wales (£798m), Scotland (£2,712m) and Northern Ireland (£715m). Within England there were also differences between regions, with higher R&D spending in the South East (£7,089m), East of England (£6,608m) and London (£5,970m) compared to other regions.[377] • Data on IUK R&D expenditure by region at baseline (2018–2019) demonstrates high levels of investment in the West Midlands, the South East, London and the South West.
	To what extent and how has the ISCF increased individual capabilities and capacities both in research and innovation?	At baseline, the level of skills and capabilities across sectors varied. Some sectors reported a good level of skills, whereas others faced shortages. In particular, several sectors faced difficulties sourcing the right type of skills, specifically individuals with experience around innovation adoption and uptake. In general, sectors lacked a programme of investment for skills.	Evidence of individuals receiving training/skills development through the ISCF (on aggregate and by Challenge)	• Data from Challenge-level baseline reports and baselining workshops showed a mixed picture in terms of skills and capabilities. Some Challenges, such as Faraday Battery and Robotics for a Safer World, report that skills were largely in place to enable delivery of the Challenges. Other Challenges, such as Audience of the Future and Future Flight, reported significant skills gaps. • More broadly, data from Challenge-level baseline reports and baselining workshops indicated that some sectors, such as health, energy sectors and nuclear, had a good level of talent and skills at baseline. In contrast, sectors such as transport and manufacturing faced challenges in sourcing the right level of skills. A challenge across several sectors was a lack of skills around deployment and adoption of innovation.

[377] While normalisation against country and regional population sizes would provide further insight on the equity of the distribution of R&D investment, the general picture would appear to be a concentration of R&D investment in England, and in particular within London and its surrounding areas, compared to the rest of the UK.

		While some sectors relied on international, in particular EU, talent, this has declined since the UK's exit from the EU. At baseline, most IUK projects reported contributions to the development of new skills or the improvement of existing ones.		In some sectors, such as IT, energy and transport, a visible programme for investment in skills was lacking.
			Examples of individual capability/capacity development	• N/A
	To what extent has the ISCF attracted additional talent and Challenge-associated skills into the UK?		Stakeholder perception regarding the extent to which the ISCF has attracted additional talent and skills	• Data from Challenge-level baseline reports and baselining workshops suggested that some sectors relied on international, in particular EU, talent at baseline, with supply of such talent negatively impacted by the UK's departure from the EU. Relevant sectors included health, IT/data and transport and space.
			Number of non-UK academics working in the Challenge areas, before the ISCF and after	• N/A
	How and to what extent has the ISCF contributed to improved infrastructure to support future R&I investment?	In 2018, there was a mixed picture in terms of R&I infrastructure across sectors. For some sectors, there were gaps in infrastructure to support R&I and need for further investment. In others, there was some existing R&I infrastructure, but this lacked coordination, and	Number of infrastructure projects/amount awarded[378]	• N/A
			Examples of ISCF-supported infrastructure that supports future R&I	• N/A

[378] Measurement of this indicator will depend upon identifying specific infrastructure projects that are in scope of the analysis. It is expected that such data will be able to be acquired through engagement with Challenge-level personnel.

		did not support scale-up and adoption.	Stakeholder perceptions regarding the extent to which the ISCF has contributed to establishment of infrastructure that supports future R&I investment	• Data from Challenge-level baseline reports and baselining workshops suggested that there was some existing R&I infrastructure for several sectors. At the same time, however, this infrastructure was generally not coordinated, did not support scale-up and adoption (e.g. more purposeful utilisation) and there were gaps within different sub-sectors. Sectors in which existing R&I infrastructure was not suited to scale-up and adoption included healthcare, energy and food and packaging.
	How has the ISCF contributed to Equality, Diversity and Inclusion?	At baseline, across most sectors, the lack of diversity in the workforce was emerging as a topic with pockets of activity but, overall, there was a lack of activity and effort behind it.	Diversity characteristics of ISCF advisory and programme boards and Challenge teams	• N/A
			Diversity characteristics of ISCF applicants, lead investigators and project partners, and application assessors (on aggregate and by Challenge)	• N/A
			Extent to which ISCF communications and engagement support EDI	• N/A
			Stakeholder perceptions of whether ISCF process and impacts have contributed to EDI	• Data from Challenge-level baseline reports and baselining workshops showed that EDI was emerging as a topic at baseline, with pockets of activity aimed at increasing diversity. Overall, however, there was a lack of activity and effort in this area. Some sectors reported that EDI was being discussed in bigger companies (e.g. CCUS) and in academia (e.g. medicines) but there was less focus in SMEs. Where EDI was being discussed, it was typically focused on certain topics, e.g. particularly around women, but wider diversity issues were not being talked about.

	To what extent has the ISCF contributed to the creation and retention of new business and high-skilled jobs?	At baseline, there was a general trend of increasing employment in R&D, with most UK R&D workers employed in higher education and engineering professions and within the public sector and the manufacturing sector. With respect to employment more generally, there was considerable business and job creation in some sectors and sub-sectors, with several others at a turning point. Across several Challenge areas, a strong unmet demand for employment was noted. In some sectors, there was considerable activity happening in terms of the creation of spin-outs.	Number of new businesses created (on aggregate, by sector[379] and by Challenge)	• N/A
			Extent to which ISCF support is associated with business performance and survival	• N/A
			Number of jobs retained and created (on aggregate and by Challenge)	• N/A
			Stakeholder perceptions regarding the extent to which jobs created have been high-skilled	• Data from the UK Labour Force Survey showed that in 2019 there were an estimated 1,026,000 R&D workers in the UK. The data also showed a general trend of increasing employment in R&D over time, with R&D occupations representing an increasing share of overall employment. Higher education teaching and engineering professionals accounted for the highest share of R&D employment at baseline. By sector, the largest share of R&D workers were employed in the public sector and the manufacturing sector. • Data from Challenge-level baseline reports showed that, in terms of overall employment, there were differences between sectors, with greater employment in some better-established sectors, including the services sector and medical technologies. Smaller sectors included the quantum technologies sector. Trends in employment growth also differed at baseline. Certain Challenges, such as Future Flight, Transforming Foundation Industries and Medicines

379 Analysis of sector will likely rely on SIC code data, which may not reflect emergence of new sectors and may not align with wider ISCF approach to defining sectors for the Challenges.

				Manufacturing, had experienced significant growth in employment, while others, such as Next Generation Services, Faraday Battery and Industrial Decarbonisation were either stable or declining in employment. • ONS data showed that in 2018 business creation varied by sector. Sectors with a high number of new enterprises established included construction, transport, legal and accounting activities and human health. • Data from baselining workshops highlighted that there were several emerging areas of R&I with increasing early-stage activity with businesses and spin-outs being created. These included the health and healthcare sector (in particular, within the areas of AI, HMP and cell and gene therapy), transport and manufacturing.
Connected innovation ecosystem	To what extent has the ISCF increased collaboration between businesses including between younger, smaller companies and larger, more established companies up the value chain?	At baseline, most participants in the ISCF across Challenges had some prior experience of business-business collaboration.	Number of collaborations between businesses (on aggregate and by Challenge)	• Data from Challenge-level baseline reports provided evidence of business-business collaboration within Challenge areas at baseline. However, there were also particular issues affecting business-business collaboration in some sectors and sub-sectors, including healthcare, SMRs and digital security.
			Number of collaborations between larger and smaller companies (on aggregate and by Challenge)	• N/A
			Centrality and connectivity metrics for networks of organisations supported by Challenges	• Network analysis of data on event attendance suggests a rich pattern of connectivity and engagement across the ISCF Challenges, with no obvious silos within the network. • Compared to event attendance data, network analysis of data on project collaboration suggests a more sparsely

				connected network comprised of fewer organisations and with some silos. Large organisations are not significantly better connected than smaller ones, but may play an important bridging role within the network.
			Perceptions of stakeholders regarding the extent to which these networks are productive and sustained beyond the life of ISCF awards	• N/A
	To what extent has the ISCF increased business-academic engagement on innovation activities relating to the Challenge areas?	There was variability in the extent to which business-academic collaborations existed at baseline, with low levels of collaboration in some areas.	Number of businesses engaged in ISCF projects (on aggregate, by sector, by business size and by Challenge)	• According to Challenge-level baseline reports, there was variability in the extent to which business-academic collaboration was prevalent within sectors at baseline • Across the Fund as a whole, a total of 5.1% of identified baseline publications included an industry author.
			Centrality and connectivity metrics for networks of organisations supported by Challenges	• Network analysis of data on event attendance suggests a rich pattern of connectivity and engagement across the ISCF Challenges, with no obvious silos within the network. • Compared to event attendance data, network analysis of data on project collaboration suggests a more sparsely connected network comprised of fewer organisations and with some silos. Large organisations are not significantly better connected than smaller ones, but may play an important bridging role within the network.
			Perceptions of stakeholders regarding the extent to which these networks are productive and sustained beyond the life of ISCF awards	• N/A
	To what extent has the ISCF increased MIDRI	There was limited evidence of multidisciplinary and	Number of cross—disciplinary projects (on aggregate and by	• On average, 13% of identified baseline publications for ISCF award holders are linked to more than one field of research, and the average number of fields of research linked to

	research around the Challenge areas?	interdisciplinary collaboration at baseline.	Challenge) and extent of cross-disciplinarity[380]	papers in the baseline publication set is 1.16, which is comparable to the IUK and UKRI average of 1.19. There is some variation between Challenges – e.g. the Manufacturing Made Smarter Challenge is particularly multidisciplinary, with 28.1% of its publications linked to more than one field of research, and the average number of fields of research linked to the publications of 1.38. On the whole, the level of multidisciplinarity at baseline is comparable to IUK and UKRI average levels. • Data from Challenge-level baseline reports showed that while there was limited evidence of multidisciplinary and interdisciplinary collaboration at baseline, some examples could be found within Challenge areas, including Future Flight and Faraday Battery.
	To what extent have institutions and clusters participating in the ISCF Challenges been recognised for their expertise within the UK and internationally?	Academic institutions in the UK are broadly considered to have world-class expertise in a range of areas relevant to Challenges. However, this recognition is not always reflected in industry reputation, where the picture is more mixed and	Evidence of awards and recognition received (on aggregate and by Challenge)[381]	• N/A
			Stakeholder perception on the extent to which participating	• Data from Challenge-level baseline reports and baselining workshops suggest that while international recognition of the UK is varied across the Challenge areas, academic institutions were broadly recognised for their expertise in the

[380] We are aware that internal analysis of MIDRI is based on 'classification areas' which list research topics associated with each grant by counting awards which are associated with two or more disciplines. We propose, assuming these data can be made available to us, to conduct a more nuanced analysis on the nature and extent of MIDRI. This would involve mapping the classification areas against existing typologies of research fields (e.g. the Australian and New Zealand Standard Research Classification Field of Research codes) that provide classification at different levels and thus measures of 'proximity' of fields. This will allow us to look at the extent of MIDRI in each award in terms of the intellectual distance between fields as well as whether it is present, and also explore the types and numbers of disciplines collaborating.

[381] Indicator refers broadly to 'evidence of', given the possibility that Researchfish and PCF forms may not produce reliable data on specific number of outputs but will likely produce useful evidence to support the evaluation. The specific evidence presented for this indicator will be refined in phase 4 of the evaluation based on data completeness, quality and availability.

		the strength is reliant on a small number of key players.	institutions and cluster expertise have been recognised	UK and internationally. However, this was often not translated into industry and entrepreneurialism. There were some areas, including cybersecurity, legal services and healthcare/life-sciences, in which the UK had a reputation as a world leader.
Economic impact	To what extent have the ISCF Challenges supported the growth of UK businesses and created new markets, or enabled increase of UK's share in global market in their respective sector?	The ISCF supports a wide variety of UK businesses working in sectors with very different characteristics. Some businesses were working in large, well-developed sectors already on the rise at baseline, while others were smaller and less well-established.	Number and characteristics of businesses supported (size, region, sector)	• N/A
			Headcount employment of ISCF-funded businesses	• Data from Challenge-level baseline reports showed that, in terms of overall employment, there were differences between sectors, with greater employment in some better-established sectors, including the services sector and medical technologies. Smaller sectors included the quantum technologies sector. Trends in employment growth also differed at baseline. Certain Challenges, such as Future Flight, Transforming Foundation Industries and Medicines Manufacturing, had experienced significant growth in employment, while others, such as Next Generation Services, Faraday Battery and Industrial Decarbonisation, were either stable or declining in employment.
			Turnover of ISCF-funded businesses	• Data from Challenge-level baseline reports showed that turnover figures varied considerably by sector, with some businesses deriving no turnover from Challenge-relevant activities pre-baseline. Trends in turnover were also mixed at baseline.
			Survival rates of ISCF-funded businesses	• N/A
	What has been the increase in gross value added (including the creation of new products and services in relevant sectors and/or the creation of new markets)?	With some exceptions, the GVA and productivity of Challenge-relevant sectors were largely increasing prior to baseline, broadly in line with wider trends for UK GVA growth.	GVA impact of the ISCF	• Data from Challenge-level baseline reports showed that absolute levels of GVA and productivity were significantly different across Challenge-relevant sectors at baseline. In several sectors, such as pharmaceutical manufacturing, agriculture, services and battery technology, productivity and GVA were increasing prior to baseline. Within the aviation, manufacturing and construction sectors, however, the overall picture was of flat or declining GVA and lower levels of productivity.

	What has been the productivity change (capital, labour or combined)?		Turnover per worker for ISCF-funded businesses	• Data from Challenge-level baseline reports showed that absolute levels of GVA and productivity were significantly different across Challenge-relevant sectors at baseline. In several sectors, such as pharmaceutical manufacturing, agriculture, services and battery technology, productivity and GVA were increasing prior to baseline. Within the aviation, manufacturing and construction sectors, however, the overall picture was of flat or declining GVA and lower levels of productivity.
			GVA impact of the ISCF per worker	• Data from Challenge-level baseline reports showed that absolute levels of GVA and productivity were significantly different across Challenge-relevant sectors at baseline. In several sectors, such as pharmaceutical manufacturing, agriculture, services and battery technology, productivity and GVA were increasing prior to baseline. Within the aviation, manufacturing and construction sectors, however, the overall picture was of flat or declining GVA and lower levels of productivity.
	While the ISCF is place-agnostic, to what extent have the economic impacts of the ISCF been widely distributed across the UK?	From the limited evidence available on Challenge-relevant UK businesses, most businesses were concentrated in London and the South East, in line with broader national trends.	Number of businesses supported by region	• ONS data showed that, in 2018, London and the South East accounted for 35% of the UK business population. • Data from Challenge-level baseline reports points to a concentration of Challenge-supported businesses in London and the South East.
			Headcount employment of businesses supported by region	• ONS data showed that the South East, East of England, and London also leaders in R&D employment, with 50,000, 42,000, and 31,000 full time equivalents (FTEs) respectively
			Turnover of businesses supported by region	• N/A

Societal impact	To what extent has the ISCF contributed to health and wellbeing benefits, including quality of life, life expectancy, reduced health inequalities and reduced healthcare costs?	At baseline, data on health indicated static or declining performance across several key metrics including life expectancy, inequality and healthcare costs.	Stakeholder perceptions regarding health and wellbeing benefits delivered and supported by the ISCF	• ONS data showed that healthy life expectancy was stalling and starting to decline in the UK at baseline. • ONS data shows that, in 2018, UK health inequalities had been broadly static over the preceding decade with a difference in life expectancy of around nine years between the most deprived and least deprived decile of society (based on an index of multiple deprivation), and an even larger disparity of around 18 years in healthy life expectancy. • ONS data showed that UK healthcare costs were growing at baseline, with growth of 47% between 2009 and 2019, and government (NHS) costs increasing by 40%.
			Perceptions and evidence from stakeholders on the extent to which the health- and wellbeing-focused Challenges are on track to achieve their mission	• N/A
			Perceptions of stakeholders on the extent to which the enabling environment (knowledge, capacity and networks) produced by the ISCF supports the delivery of health and wellbeing impacts	• N/A
			Examples of impact of ISCF on health and wellbeing	• N/A

	To what extent has the ISCF contributed environmental and sustainability benefits, including reduced emissions, progress towards net zero, and growth of the circular economy?	At baseline, environmental and sustainability issues were already on the agenda – and resonating with the public – but progress had been mixed, with GHG emissions still relatively flat. ISCF Challenges are targeting some of the key sectors identified as having high emissions at baseline.	Stakeholder perceptions regarding environmental and sustainability benefits delivered and supported by the ISCF	• ONS data showed that there had been significant growth in renewable energy in the UK at baseline, with renewables rising from 6% to 39% of the UK's electricity supply between 2009 and 2019. • ONS data showed that there had been modest increases in the proportion of household waste recycled in the UK at baseline, rising from 40% in 2010 to 45% in 2019. Material consumption fell by 19% relative to GDP between 2009 and 2018. • ONS data showed that overall, UK greenhouse gas emissions were relatively flat though slowly decreasing at baseline, with a decrease of 17% between 2009 and 2019. Some Challenge areas were aligned with disproportionately polluting industries, such as manufacturing, transport and energy. • ONS data showed that public support for environmental action was already high in the UK at baseline. For example, a majority of the public supported renewable energy developments of all types, and engaged in energy-saving behaviours in their homes.
			Perceptions of stakeholders on the extent to which the enabling environment (knowledge, capacity and networks) produced by the ISCF supports the delivery of environmental and sustainability impacts	• N/A

			Perceptions and evidence from stakeholders on the extent to which the environment- and sustainability-focused Challenges are on track to achieve their mission	• N/A
	To what extent has the ISCF contributed benefits to infrastructure and services including broadened access, increased resilience and increased safety?	Not addressed at baseline stage	Stakeholder perceptions regarding infrastructure and services benefits delivered and supported by the ISCF	• N/A
			Perceptions of stakeholders on the extent to which the enabling environment (knowledge, capacity and networks) produced by the ISCF supports the delivery of infrastructure and services impacts	• N/A
			Perceptions and evidence from stakeholders on the extent to which the infrastructure- and services-focused Challenges are on track to achieve their mission	• N/A
			Examples of the impact of the ISCF on infrastructure and services	• N/A
	To what extent has the ISCF contributed wider societal benefits, including unexpected and	Not addressed at baseline stage	Stakeholder perceptions regarding wider benefits delivered by the ISCF, including	• N/A

	unintended consequences?		unexpected/unanticipated impacts	
			Examples of wider impacts of the ISCF, including unexpected/unanticipated impacts	• N/A
Value for money	To what extent does the ISCF represent value for money?	Not addressed at baseline stage	Total economic cost of implementing the ISCF (including public and private investment)	• N/A
			Return on investment (ROI) based on total economic benefits relative to total economic costs (total benefits includes non-market valuations, e.g. of environmental outcomes, where feasible to do so)	• N/A
			Wider judgement of ROI, taking into account overall impact on knowledge, society and the economy relative to size of investment	• N/A