

## Annex A. Method for the REA on evaluation of mission-oriented R&I

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### A.1. Overview

This annex provides a detailed description of the methodological approach we adopted for the rapid evidence assessment (REA). We conducted a structured review of the available academic and grey literature on evaluation of mission-oriented R&I. A rapid evidence assessment draws on the principles of a systematic review in taking a robust and replicable approach to searching and reviewing the literature. However, REAs take a slightly more pragmatic approach to the scope and coverage of literature, limiting study inclusion by using a range of criteria that can be adjusted in response to the volume of literature identified, enabling them to be conducted within a more limited timeframe. The remaining sections set out our approach across four tasks:

- Conducting searches
- Screening
- Extraction
- Snowballing
- Analysis

### A.2. Conducting searches

We developed a search strategy with input from UKRI. Our set of search terms and our search criteria are presented in Table 35. The search was conducted in Scopus and Google Scholar to ensure coverage of relevant academic and grey literature. For the Google Scholar search, a slightly adapted version of the search string was used due to character limitations. The string used is presented in Table 36. The publication timeframe was restricted to 2010 onwards to capture literature from the past 10 years, and only publications published in English were considered. Following removal of duplicate articles, a total of 813 relevant studies were identified for screening.

**Table 35: Search terms used for the rapid evidence assessment**

evaluat* OR assess*
AND
"mission oriented" OR mission-oriented OR "mission led" OR mission-led OR "mission-based" OR mission-based OR moonshot OR moon-shot OR "grand challenge*" OR "challenge led" OR challenge-led OR challenge-oriented OR "challenge oriented" OR "challenge driven" OR challenge-driven OR "industr* challenge*"
AND
research OR innovation OR R&I OR "research and development" OR R&D OR polic*

**Table 36: Adapted search terms used for the Google Scholar search**

Evaluat* OR assess*
AND
mission* OR "mission oriented" OR mission-oriented OR mission-led OR mission-based OR moonshot OR "grand challenge" OR challenge-led or challenge-oriented OR "industr* challenge*"
AND
research OR innovation

### A.3. Screening

We screened articles by title and abstract for relevance against predefined inclusion and exclusion criteria. The criteria used are set out in Table 37.

**Table 37: Inclusion and exclusion criteria for the literature review**

Criterion	Include	Exclude	Rationale
<b>Topic relevance</b>	Papers where evaluation of mission-oriented R&I is a central focus	Papers where evaluation of mission-oriented R&I is not a central focus	The aim is to identify literature exploring evaluation of mission-oriented R&I
<b>Geographical location</b>	All countries	N/A	To provide a global overview of evaluation of mission-oriented R&I, we will not restrict the search to any particular countries
<b>Year of publication</b>	2010 onwards	2009 or earlier (with some exceptions, e.g. any seminal studies referenced in multiple publications within the 10-year timeframe)	We propose this time period (10 years) in order to strike a balance between identifying up-to-date, relevant material and keeping the date range broad enough to yield sufficient results
<b>Study type</b>	Peer-reviewed journal publications, conference proceedings, grey literature with clear authorship	Documents without clear organisational authorship, theoretical work, letters, editorials, comments or opinion pieces, book reviews, sub-PhD level theses	The 'study type' selection criteria are intended to optimise the quality of sources in the literature search
<b>Language</b>	English	Other languages	It is expected that literature searches applying the English-language search terms will yield mostly English-language sources

The inclusion/exclusion criteria were applied in three stages:

- Criteria were applied on the titles. Those appearing to fit the criteria, or where there was uncertainty, were included.
- The abstracts of these titles were read, and inclusion criteria applied again. Those fitting the criteria or those where there was uncertainty were included. In these first two stages, we were overinclusive to avoid excluding potentially relevant studies.
- Reviewers retrieved full reports of studies passing the first two round. Each criterion was then applied again at the full text level.

Following screening, a total of 49 studies were identified as meeting the inclusion criteria.

## A.4. Extraction

In this stage, information was extracted from each included publication to facilitate cross-analysis against the key study questions and themes, and the quality of the studies included was assessed to inform that analysis.

Following piloting, researchers independently recorded data about each selected paper meeting the inclusion criteria, including both general information on the publication and information on the elements of each study question it addresses. We captured information from each included study in a standard template in Excel, in line with the aims and objectives of this study:

### **General information about the evidence source**

- Document reference
- Type of document (e.g. journal article, evaluation report)
- Year of publication
- Brief description of the document purpose and objectives
- Alternative terms to ‘mission-oriented R&I’ (capture these)
- Why mission-oriented R&I?

### **Examples of mission-oriented R&I programmes**

- Name of mission-oriented R&I programme
- Organisation(s) overseeing mission-oriented R&I programme
- Objectives and/or anticipated impacts/outcomes of the mission-oriented R&I programme
- Country setting of mission-oriented R&I programme
- Discipline/field of mission-led R&I programme
- Budget of mission-oriented R&I programme
- Timescale of mission-oriented R&I programme
- Delivery of mission-oriented R&I programme
- Has the mission-oriented R&I programme been assessed/reviewed/evaluated (Y/N/Unclear)

### **Evaluating mission-oriented R&I**

- Timescale of evaluation
- Methods for evaluating mission-oriented R&I
- Challenges of evaluating mission-oriented research
- Impacts and/or outcomes of mission-oriented R&I?
- Evaluation findings on the benefits of mission-oriented approach
- Evaluation findings on the challenges of mission-oriented approach
- Proposed methods for evaluating mission-oriented R&I

- Proposed challenges of evaluating mission-oriented R&I
- What makes for effective evaluation of mission-oriented R&I?

**Other comments**

## A.5. Snowballing

During extraction, we also identified additional literature through ‘snowballing’. In this process, we identified a small number of additional relevant studies, based on review of the reference lists of selected included studies. A total of 10 papers were added through this process, thereby bringing the total number of papers included within the REA to 59.

## A.6. Analysis

The evidence was brought together using a framework synthesis approach based on the framework set out in our evidence extraction approach.

Each element of the framework was explored initially by a member of the study team to identify key trends and emerging issues. Findings were then discussed with other members of the team, and explored further. Through an iterative process of analysis and discussion, we were able to identify a set of key emerging findings, which are set out in this report.

## Annex B. List of papers reviewed by REA on evaluation of mission-oriented R&I

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### B.1. List of included documents

1. Amanatidou, E., P. Cunningham, A. Gök and I. Garefi (2014). 'Using Evaluation Research as a Means for Policy Analysis in a 'New' Mission-Oriented Policy Context.' *Minerva* 52(4): 419-438.
2. Biegelbauer, P., C. Hartmann, W. Polt, A. Wang and M. Weber (2020). 'Mission-Oriented Innovation Policies in Austria—a case study for the OECD.'
3. Boon, W. and J. Edler (2015). The missing links—demand based policy making and instruments in the context of mission orientation: Concepts, impacts, governance challenges. The Book of Abstracts for The 2015 Annual Conference of the EU-SPRI Forum.
4. Boon, W. and J. Edler (2018). 'Demand, challenges, and innovation. Making sense of new trends in innovation policy.' *Science and Public Policy* 45(4): 435-447.
5. Casadevall, A. and F. C. Fang (2016). 'Moonshot science—Risks and benefits.' *MBio* 7(4).
6. Chang & Liu (2019) Methods and Practices for Institutional Benchmarking based on Research Impact and Competitiveness: A Case Study of ShanghaiTech University.
7. Chicot J. and Mireille Matt, 2018. 'Public procurement of innovation: a review of rationales, designs, and contributions to grand challenges,' *Science and Public Policy*, Oxford University Press, vol. 45(4), pages 480-492.
8. Choi T (2017) Mission-oriented evaluation system of Government-funded Research Institutes in Korea.
9. Craig, S.D., Graesser, A.C. & Perez, R.S. Advances from the Office of Naval Research STEM Grand Challenge: expanding the boundaries of intelligent tutoring systems. *IJ STEM Ed* 5, 11 (2018). <https://doi.org/10.1186/s40594-018-0111-x>.
10. Deleidi, M. and M. Mazzucato (2020). 'Directed innovation policies and the supermultiplier: An empirical assessment of mission-oriented policies in the US economy.' *Research Policy*.
11. Domini, A. and J. Chicot (2018). Case Study Report: From Concorde to Airbus.
12. Efstathiou, S. (2016). 'Is it possible to give scientific solutions to Grand Challenges? On the idea of grand challenges for life science research.' *Studies in History and Philosophy of Science Part C :Studies in History and Philosophy of Biological and Biomedical Sciences* 56: 48-61.
13. Ek I. (2018) Research Programmes that Address Societal Challenges — Aligning Policy, Implementation, and Expected Impact. *Foresight and STI Governance*, vol. 12, no 3, pp. 13–19. DOI: 10.17323/2500-2597.2018.3.13.19.

14. Fisher, R., J. Chicot, A. Domini and M. Misojcic (2018). 'Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach.'
15. Foray, D. Smart specialization strategies as a case of mission-oriented policy—a case study on the emergence of new policy practices, *Industrial and Corporate Change*, Volume 27, Issue 5, October 2018, Pages 817–832, <https://doi.org/10.1093/icc/dty030>.
16. Fritz, T. M. And G. Von Schnurbein (2019). 'Beyond socially responsible investing: Effects of mission-driven portfolio selection.' *Sustainability (Switzerland)* 11(23).
17. Geels, O. (2019). Lessons for the formulation and execution of mission-oriented innovation policy A comparative case study of regional energy strategies in the Netherlands.
18. Gibson, C. Tamantha Stutchbury, Victoria Ikutegbe, Nicole Michielin, Challenge-led interdisciplinary research in practice: Program design, early career research, and a dialogic approach to building unlikely collaborations, *Research Evaluation*, Volume 28, Issue 1, January 2019, Pages 51–62, <https://doi.org/10.1093/reseval/rvy039>.
19. Hamel, W. (2010). Measurement of autonomous operation. PerMIS '10: Proceedings of the 10<sup>th</sup> Performance Metrics for Intelligent Systems Workshop September 2010 Pages 112–118.
20. Hayter, C. S. (2015). The Grand Challenge Model of R & D. The Oxford Handbook of Local Competitiveness, Oxford University Press: 237.
21. Hekkert, M. P., M. J. Janssen, J. H. Wesseling and S. O. Negro (2020). 'Mission-oriented innovation systems.' Environmental Innovation and Societal Transitions 34: 76-79.
22. Hudson L. Mendonça, T. D. L. v. A. d. M.-S., Marcus Vinicius de A. Fonseca (2018). 'Working towards a framework based on mission-oriented practices for assessing renewable energy innovation policies.' Journal of Cleaner Production 193: 709-719.
23. Janssen, M. J., J. C. L. Torrens, J. Wesseling, I. Wanzenböck and J. Patterson 'Position paper 'Mission-oriented innovation policy observatory''
24. Joly, P.-B. and M. Matt (2017). 'Towards a new generation of research impact assessment approaches.' The Journal of Technology Transfer: 1-11.
25. Kattel, R. and M. Mazzucato (2018). Mission-oriented innovation policy and dynamic capabilities in the public sector, Oxford University Press.
26. Kroll, H. (2016). Supporting new strategic models of science-industry R&D collaboration: A review of global experiences, *Arbeitspapiere Unternehmen und Region*.
27. Kuhlmann, S. and A. Rip (2019). Next generation science policy and Grand Challenges. Handbook on Science and Public Policy, Edward Elgar Publishing.
28. Lalli, M., H. Ruysen, H. Blencowe, K. Yee, K. Clune, M. DeSilva, M. Leffler, E. Hillman, H. El-Noush, J. Mulligan, J. C. Murray, K. Silver and J. E. Lawn (2018). 'Saving Lives at Birth; development of a retrospective theory of change, impact framework and prioritised metrics.' Globalization and Health 14(1).
29. Liotard, I. and V. Revest (2018). 'Contests as innovation policy instruments: Lessons from the US federal agencies' experience.' Technological Forecasting and Social Change 127: 57-69
30. Martínez, C. 'Mutual Learning Exercise project on (Evaluation) of Complex PPPs Programs in Science, Technology and Innovation (STI).'
31. Mazzucato, M. (2019). 'Governing missions in the European Union.' Independent Expert Report.

32. Mazzucato, M., R. Kattel and J. Ryan-Collins (2020). 'Challenge-Driven Innovation Policy: Towards a New Policy Toolkit.' Journal of Industry, Competition and Trade 20(2): 421-437.
33. Milner, K. M., R. Bernal Salazar, S. Bhopal, A. Brentani, P. R. Britto, T. Dua, M. Gladstone, E. Goh, J. Hamadani, R. Hughes, B. Kirkwood, M. Kohli-Lynch, K. Manji, V. Ponce Hardy, J. Radner, M. A. Rasheed, S. Sharma, K. L. Silver, C. Tann and J. E. Lawn (2019). 'Contextual design choices and partnerships for scaling early child development programmes.' Archives of Disease in Childhood 104: S22-S33.
34. Modic, D. and M. P. Feldman (2017). 'Mapping the human brain: Comparing the US and EU Grand Challenges.' Science and Public Policy 44(3): 440-449.
35. Pinnington, R. and C. Barnett (2019). Research for development (R4D) indicators: A review of funder practice.
36. Polt, W., K. Schuch, M. Weber, E. Dall, M. Unger and N. Salamon (2019). 'Debating Impact and missionorientation of R&I Policies.' Fteval Journal for Research and Technology Policy Evaluation 47:7-12.
37. Præst Knudsen M., Tina Lundø Tranekjer & Nadika Bulathsinhala (2019) Advancing large-scale R&D projects towards grand challenges through involvement of organizational knowledge integrators, *Industry and Innovation*, 26:1, 1-30, DOI: 10.1080/13662716.2017.1409103
38. Riera C. et al (2017) Mutual Learning Exercise project on (Evaluation) of Complex PPPs Programs in Science, Technology and Innovation (STI)
39. Salas Gironés, E., R. van Est and G. Verbong (2019). 'Transforming mobility: The Dutch smart mobility policy as an example of a transformative STI policy.' Science and Public Policy 46(6): 820-833.
40. Shimada, Y. A., N. Tsukada and J. Suzuki (2017). 'Promoting diversity in science in Japan through mission-oriented research grants.' Scientometrics 110(3): 1415-1435.
41. Tizian M. Fritz and Georg von Schnurbein (2019). Beyond Socially Responsible Investing: Effects of Mission-Driven Portfolio Selection. *Sustainability*.
42. Unger, M. and W. Polt (2017). 'The knowledge triangle between research, education and innovation—a conceptual discussion.' Ф о р с а й т 11(2 (eng)).
43. Van Asten, A. C. (2014). 'On the added value of forensic science and grand innovation challenges for the forensic community.' Science and Justice 54(2): 170-179.
44. van Drooge, L. and J. Deuten (2016). 'Joint evaluation for joint governance of challenge-oriented research 🤔formerly known as: Evaluation and governance-and why the twain shall meet).'
45. van Drooge, L. and J. Spaapen (2017). 'Evaluation and monitoring of transdisciplinary collaborations.' The Journal of Technology Transfer: 1-15.
46. Veugelers, R., M. Cincera, R. Frietsch, C. Rammer, T. Schubert, A. Pelle, A. Renda, C. Montalvo and J. Leijten (2015). 'The impact of horizon 2020 on innovation in Europe.' Intereconomics 50(1): 4-30.
47. Wesseling, J. and N. Meijerhof (2020). 'Development and application of a Mission-oriented Innovation Systems (MIS) approach.'
48. Wittmann, F., M. Hufnagl, R. Lindner, F. Roth and J. Edler (2020). 'Developing a typology for mission-oriented innovation policies, Fraunhofer ISI Discussion Papers-Innovation Systems and Policy Analysis'.



49. Yaghmaei (2018) ‘Responsible research and innovation key performance indicators in industry: a case study in the ICT domain’.

## B.2. List of additional papers ‘snowballed’

1. Alexander, L. (2008). ‘A New Manhattan Project for Clean Energy Independence.’ Issues in Science and Technology 24(4): 39.
2. Bonner, J. (2019). ‘U.S. Losing Ground as Global Innovation Powerhouse; China and South Korea Take Top Spots.’ State of Innovation in Asia: Key Industries and Players Shaping Asia’s Innoovative Ecosystem Retrieved 09/02/2021, 2021.
3. Ergas, H. (1987), ‘Does technology policy matter?’ in Technology and Global Industry: Companies and nations in the world economy. National Academies Press: Washington, DC, pp. 191–245.
4. European Commission (EC)/OECD (2020), STIP Compass: International Database on Science, Technology and Innovation Policy (STIP), edition 2/9/2021, <https://stip.oecd.org>.
5. Georghiou, L. a. R., John and Cameron, Hugh and Vonortas, Nick and Prastacos, Gregory and Spanos, Yiannis and Kuhlmann, Stefan and Heinze, Thomas and Bach, Laurent and Cohendet, Patrick and Ledoux, Marc and Matt, Mireille and Polt, Wolfgang and Schibany, Andreas and Fritz, Oliver and Nyiri, Lajos and Havas, Attila and Guy, Ken (2002) Technical Report. Manchester. Assessing the Socio-economic Impacts of the Framework Programme. Manchester, University of Manchester 368.
6. Kaldewey, D. (2018). ‘The Grand Challenges Discourse: Transforming Identity Work in Science and Science Policy.’ Minerva 56: 161-182.
7. OECD, E. C. (2020). ‘STIP Compass: International Database on Science, Technology and Innovation Policy (STIP).’ 2/9/2021.
8. Rodrik, D. (2004). Industrial policy for the twenty-first century. John F. Kennedy School of Government Working Paper Series, John F. Kennedy School of Government
9. van Drooge, L. and J. Deuten (2016). ‘Joint evaluation for joint governance of challenge-oriented research 😊 (formerly known as: Evaluation and governance-and why the twain shall meet).’
10. Ward, C. R. M. (2020). Research & Development Spending. London, Office of National Statistics.

## Annex C. List of examples of mission-oriented R&I programmes

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### C.1. Overview

Building on the selected examples of mission-oriented research and R&I programmes presented in Chapter 2, this annex presents a longer list of examples of mission-oriented programmes. The list draws both on programmes encountered during the REA, and on discussion with stakeholders with knowledge of mission-oriented R&I.

The focus of the REA was on the evaluation of mission-oriented R&I. As such, the REA has captured information on mission-oriented R&I programmes only when those programmes are discussed in articles with a central focus on evaluation. The table below should not therefore be considered an exhaustive list of all mission-oriented R&I programmes.

**Table 38: List of examples of mission-oriented R&I programmes**

Name of mission-oriented programme	Funder	Geographical setting	Sector/discipline	Budget	Planned timetable	Source
<b>NRC Challenge Programme</b>	NRC national programme office  Collaborations with Canadian government  NRC Ideation Fund	Canada	Cross-cutting (includes AI, Internet of things, construction and aerospace)	\$150m over 5 years + \$30m per year to fund multi-party R&D programmes. Additional \$15m granted to support Covid-19 research	7 years for each programme	<a href="https://nrc.canada.ca/en/research-development/research-collaboration/programs/challenge-programs">https://nrc.canada.ca/en/research-development/research-collaboration/programs/challenge-programs</a>
<b>ImPact Canada Initiative</b>	Impact and Innovation Unit of the Privy Council Office  Collaborations with Canadian government	Canada	Cross-cutting (includes housing, energy, smart cities)	Up to 25 finalists will receive \$100,000 each to enter stage 2 development phase  For e.g. \$300m (£1.7m) over 5 years to support Housing Supply Challenge	Approx. 1 year (Oct 23-2020 – Oct 2021)	<a href="https://impact.canada.ca/en/node/19">https://impact.canada.ca/en/node/19</a>  <a href="https://impact.canada.ca/en/challenges/housing-supply-challenge/process">https://impact.canada.ca/en/challenges/housing-supply-challenge/process</a>
<b>ImPACT (Impulsing Paradigm)</b>	Cabinet office	Japan	Science, Technology, Innovation	55bn Japanese Yen for	Different time scales for	-

Change through disruptive Technologies Program)				2013 fiscal year	different programmes  E.g. Realizing Ultra-Thin and Flexible Tough Polymers project 2001–2013	
Moonshot R&D programme	Cabinet office	Japan	Cross-cutting (includes super-aging populations, global warming)	100bn Japanese Yen (£730m) in FY2018 as setup 15bn Japanese Yen for FY2019 onwards.	2013–2050	<a href="https://www8.cao.go.jp/cstp/english/moonshot/top.html">https://www8.cao.go.jp/cstp/english/moonshot/top.html</a>
Vinnova challenge-driven innovation programme	CDI (Challenge Driven Innovation)	Sweden	Sustainability, innovation	Projects within programmes are granted seed funding of equivalent £43k for Stage 1 (development) and £1.7m for Stage 3 (implementation)	2011–	<a href="https://www.vinnova.se/contentassets/6bf9b3642c2b492e8cc5e6a7c8bce955/cdi-program-description-171025.pdf">https://www.vinnova.se/contentassets/6bf9b3642c2b492e8cc5e6a7c8bce955/cdi-program-description-171025.pdf</a>
DARPA (Defense Advanced Research Project Agency)	US Department of Defense	USA	Defence, security and technology	FY2020 request is \$3.6bn (£2.7bn)  FY2019 enacted	Contracts are 3–5 years	<a href="https://www.darpa.mil/">https://www.darpa.mil/</a> <a href="https://www.darpa.mil/work-with-us/heilmeier-catechism">https://www.darpa.mil/work-with-us/heilmeier-catechism</a>

				budget was \$3.427bn		
<b>ARPA-E (The Advanced Research Projects Agency-Energy)</b>	US Department of Energy	USA	Technology, energy	<p>Since 2009 ARPA-E has provided \$2.4bn R&amp;D funding across more than 975 projects</p> <p>Received \$366m in FY2019, and \$425m in FY2020</p>	Contracts are for 3–5 years	<p><a href="https://arpa-e.energy.gov/technologies/project-guidance">https://arpa-e.energy.gov/technologies/project-guidance</a></p> <p><a href="https://arpa-e.energy.gov/">https://arpa-e.energy.gov/</a></p>
<b>BRAIN (Brain Research through Advancing Innovative Neuro-technologies) Initiative</b>	Private and public funders	USA	Health (neuroscience)	The <i>BRAIN 2025</i> report calls for an escalating budget to reach \$500m per year by FY2019, for a total 12-year budget of \$4.5bn	April 2013–2025	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach
<b>Delta Programme</b>	Delta Fund	Netherlands	Security and resilience, climate change	An average of €1.25bn a year has been earmarked for the Delta Fund up to 2032	1937–2050	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach

<b>e-Estonia</b>	Private sector partners EU funding	Estonia	IT/digitalisation (multisectorial)	Total EU spend in Estonia – €0.759bn in 2018	1997–current	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach
<b>New Energy Vehicles (NEVs)</b>	Asia-Pacific Economic Corporation (APEC)	China	Transport	Not available	2001–2020/2025	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach
<b>Human Brain Project</b>	HBP Directorate (executive governance body of the project) Co-funded by the EU	Participating EU country members	Neuroscience, computing	Total max EU contribution to the Flagship currently stands at €406m  Ramp Up Phase began on 1 October 2013 for 30 months. Budget for this period was €72.5m (€54m was contributed by the EU)	2013–2023	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach  Modic, D. and M. P. Feldman (2017). Mapping the human brain: Comparing the US and EU Grand Challenges
<b>Solar energy in Chinese Five-Year Plans</b>	Independent power producers  Public private partnerships	China	Energy	Not available	2011–2020 13 <sup>th</sup> Five Year Plan: 2016–2020	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach
<b>Airbus</b>	UK government and French government support financially their	France, Germany, Spain and the	Transport	\$40bn (estimated)	1967–present	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach

	national aerospace industries via Repayable Launch Investments	UK		total government subsidy since its inception) Not possible to determine the investment made by the private companies over the development of the Airbus consortium and after the complete privatisation of it		Domini A. & Chicot J. (2018): Mission-oriented R&I policies: In-depth case studies. Case study report. From Concorde to Airbus
<b>Apollo Project</b>	Congress NASA Funding	USA	Aerospace	\$28bn 1960–973 (198stimat \$283bn when adjusted for inflation) Total amount spent on NASA during this period was \$49.4bn (\$482 bn adjusted)	1961–1972	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach
<b>Concorde</b>	UK government and French government support financially their	France, UK	Aerospace	Total cost 198stim ate up to £	1962–2003	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach

	national aerospace industries via Repayable Launch Investments			1.3bn (early estimations foresaw a global cost of £150m). It is not possible to estimate the exact amount of the operation, due to the confidentiality of the financial documents.		Domini A. & Chicot J. (2018): Mission-oriented R&I policies: In-depth case studies. Case study report. From Concorde to Airbus
<b>SunShot Initiative</b>	Department of Energy	USA	Energy	Not reported	2011–2030	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach.
<b>War on Cancer</b>	NCI (National Cancer Institute)	USA	Health	nearly \$1.6bn in federal funding to cancer research that was spread over three years	1971–2016	Fisher et al., (2017): Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach
<b>Saving Brains, Grand Challenges Canada (GCC)</b>	Development Innovation Fund Health Grand Challenges Canada	LMICs (countries not specified)	Early child development	Between 2011–2016, Saving Brains invested CAN\$43m in 108 grants to teams based in LMICs	2011–2016	Milner KM, Bernal R, Bhopal S, et al (2019): Contextual design choices and partnerships for scaling early child development programmes Archives of Disease in Childhood



				Grand Challenges Canada also provided \$18m CAD		
<b>Office of Naval Research's STEM Grand Challenge</b>	Office of Naval Research (ONR)	USA	STEM	ONR released a request for proposals for phase 1, in which four awards would be made of up to \$1.5m each. At the conclusion of phase 1, ONR would select two awards for military applications of up to \$1m each.	Aug 2011– Winter 2012	Craig, S.D., Graesser, A.C. & Perez, R.S. (2018): Advances from the Office of Naval Research STEM Grand Challenge: expanding the boundaries of intelligent tutoring systems.
<b>Challenge Programme on Water and Food</b>	Consultative Group on International Agricultural Research (CGIAR)	Africa, Asia, Latin America	Agriculture	Not reported	Launched in 2002	van Drooge, L. and J. Deuten (2016). Joint evaluation for joint governance of challenge-oriented research: (formerly known as: Evaluation and governance-and why the twain shall meet).
<b>Advancing Innovative Neurotechnologies Grand Challenge</b>	Brain Research through Advancing Innovative Neurotechnologies (BRAIN)	USA	Neuroscience	Not reported	Not reported	

<b>University of Wollongong's Global Challenges Program</b>	Trusts & foundations e.g. Abbott foundation  Private donors	Australia	Radical interdisciplinarity (brings together researchers without a 'natural fit': who do not previously envisage working together)	Funding was structured around tiers of low-level strategic (\$5,000), seed (\$15,000), and project funding (\$50,000 p.a. for up to 3 years)	2013–present  5 years at first, extended to a further 5 after the evaluation	Gibson C., Victoria Ikutegbe et al (2019). Challenge-led interdisciplinary research in practice: Program design, early career research, and a dialogic approach to building unlikely collaborations
<b>Pilot Regional Energy Strategy (RES) program</b>	Collaboration between the Ministry of Economic Affairs (EZK), the Ministry of Infrastructure and the Environment (IenM), the Ministry of the Interior and Kingdom	Netherlands	Climate change	Not reported	The pilot Regional Energy Strategy programme (pilot regions) was between June 2016–Oct 2017. The actual strategy began in 2019	Geels, O. (2019). Lessons for the formulation and execution of mission-oriented innovation policy: A comparative case study of regional energy strategies in the Netherlands.
<b>Global Challenges Research Fund</b>	UKRI and other partners: Scottish Funding Council, Higher Education Funding Council for Wales, Higher Education Division Northern Ireland, Academy of Medical Sciences, Royal Society, British Academy, Royal Academy of Engineering and UKSA	Developing countries	Multisectoral (e.g. UN's Sustainable Development Goals)	£1.5bn fund supports cutting-edge research to address challenges faced by developing countries. Part of the UK's official development assistance (ODA).	The first phase of the GCRF is a five-year programme 2016–2021	Pinnington, R. and C. Barnett (2019). Research for development (R4D) indicators: A review of funder practice.

				UKRI awarded between £13m and £20m each over five years to 12 interdisciplinary research hubs working across a range of development challenges.		
<b>ForskEL</b>	Danish National Funding Program	Denmark	Renewable energy technologies	130m Danish kroner annually	1988–2008	Mette K., Tina, Tranekjer L. & Bulathsinhala N. (2019) Advancing large-scale R&D projects towards grand challenges through involvement of organizational knowledge integrators, Industry and Innovation

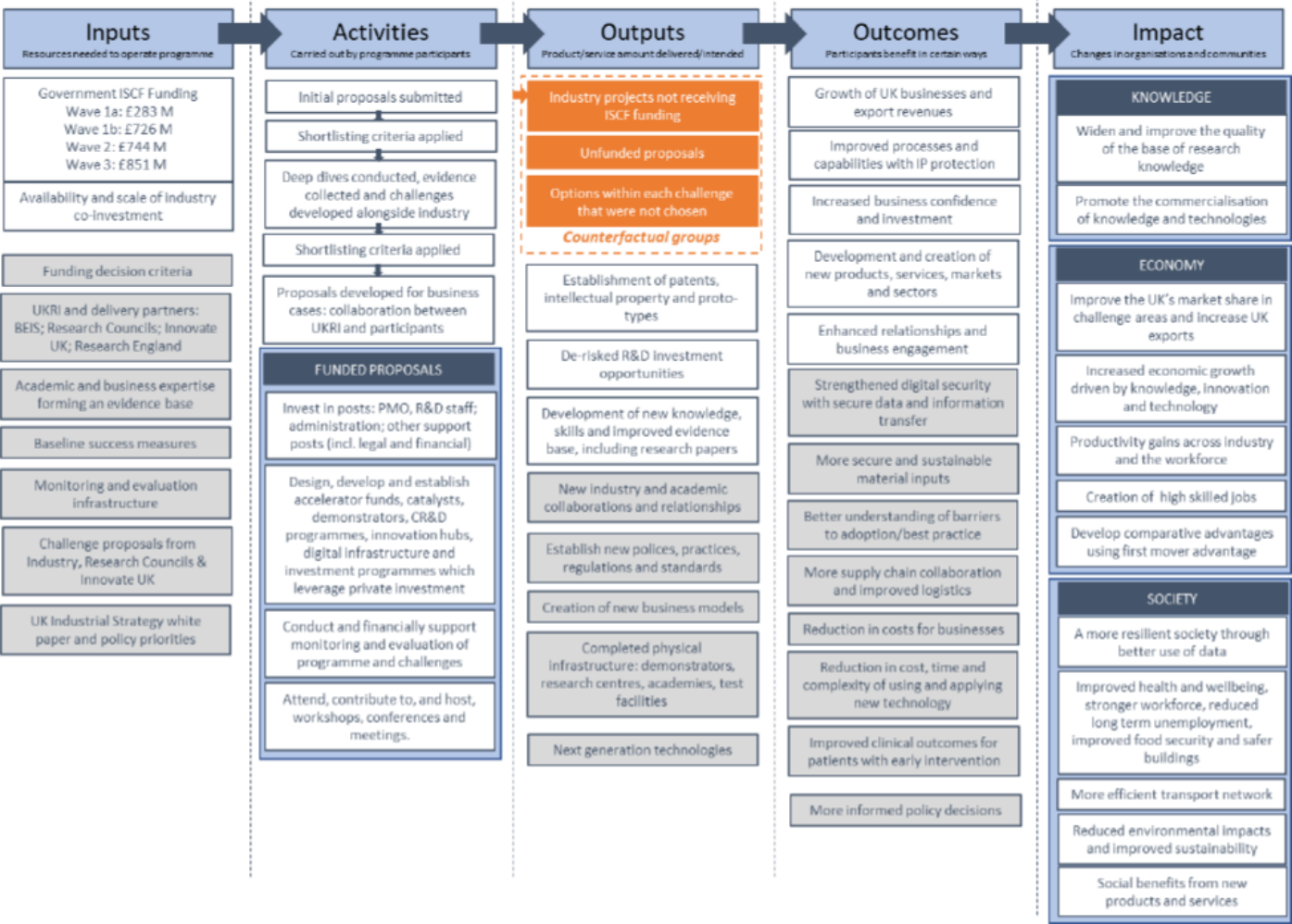
## Annex D. ISCF logic model

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### D.1. Overview

This annex presents the initial ISCF logic model developed at the time of inception of the Fund. The logic model has informed development of the ISCF ToC presented within this evaluation framework report. More information on our approach to developing the ISCF ToC can be found in Annex E.

Figure 7: ISCF logic model



## Annex E. 'Strawman' ISCF Theory of Change

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### E.1. Overview

This annex presents the 'strawman' ToC developed for a workshop with the ISCF evaluation working group on 18<sup>th</sup> January 2020.

Using a bottom-up approach, the research team reviewed the Challenge-level evaluations and extracted each individual item of their ToCs. Next, items were divided by category (e.g. input, activity, etc.) and clustered items by high-level themes under each category. These themes were discussed and modified in an internal workshop to develop a Challenge-level ToC. In parallel, a senior member of the research team examined the existing ISCF ToC, current ISCF aims and processes, and input received at the inception meeting to create a modified Fund-level ToC, which in turn was mapped against the Challenge-level ToC to create a new Fund-level ToC. Using the ISCF Benefits Register, a list of all the benefits identified by the Challenges, the team then ensured the new Fund-level 'strawman' ToC items reflected the envisioned benefits of the Challenges by adjusting the ToC accordingly wherever this was not the case.

Figure 8: Developing the strawman ToC

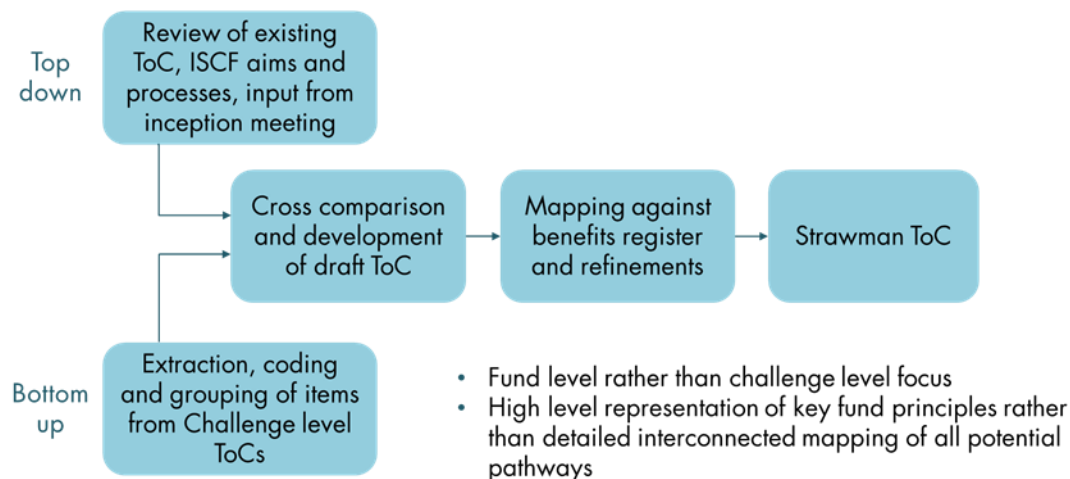
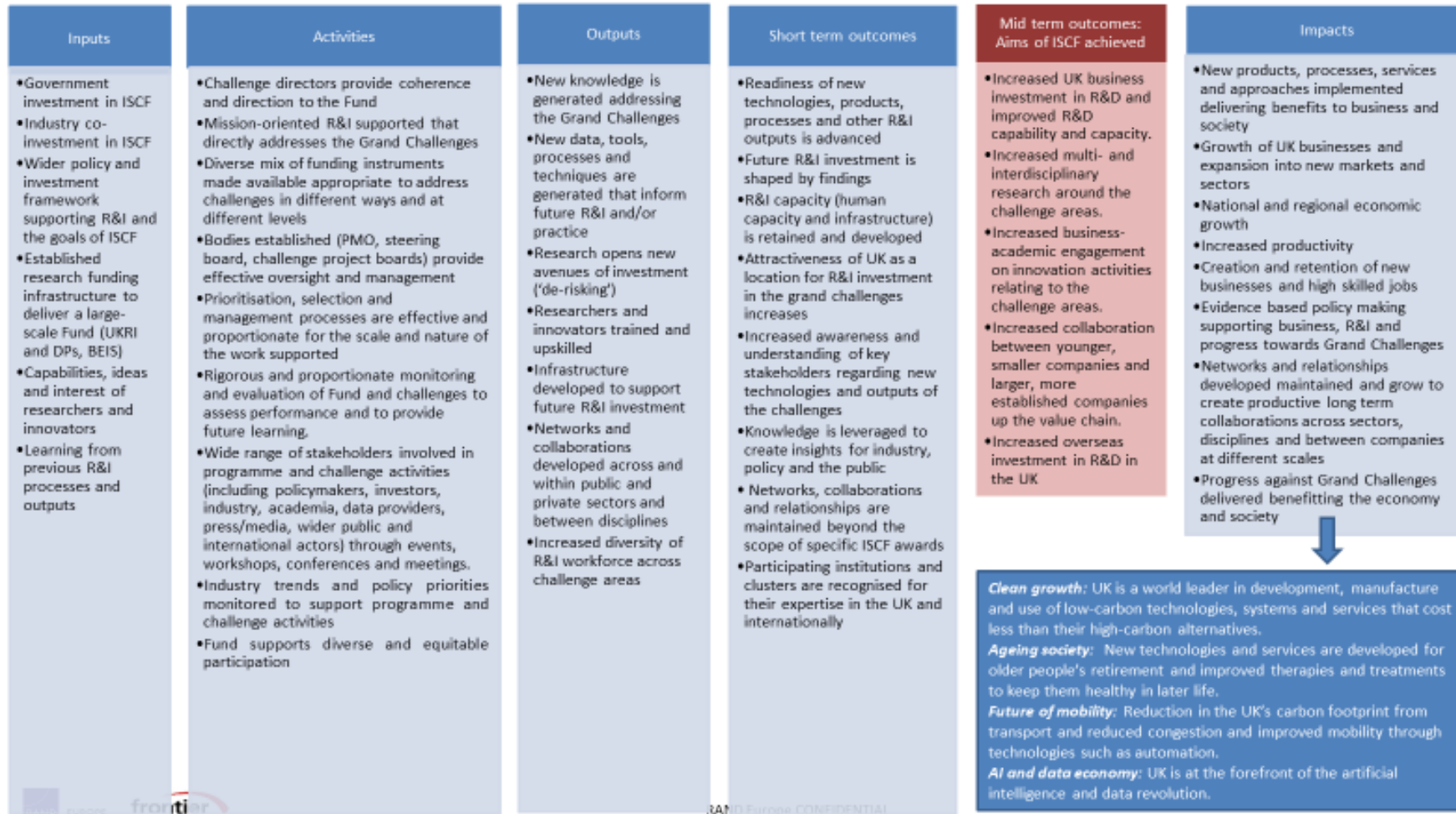


Figure 9: 'Strawman' ISCF ToC



## Annex F. Notes from the Theory of Change workshop

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### F.1. Overview

As part of the Fund-level evaluation of ISCF, a workshop was held on 18/01/2021 with the evaluation working group to discuss the Fund's ToC. Prior to that meeting, the evaluation team shared a 'strawman' ToC which is shown in Annex E as a stimulus for discussion. This annex presents a summary of the key discussion points and takeaways from the workshop. The workshop takeaways enabled the evaluation team to revise the ToC to provide a better representation of the aims and activities of the Fund.

### F.2. General

- The ToC is a very important part of the evaluation – not just a diagram that sits at the front of an evaluation report. The ToC should provide a robust framework for the evaluation
- The strawman ToC is more of a logic model than a ToC. It requires more in the way change mechanisms, assumptions and feedback loops in order to be a fully fledged ToC
- There is a need to understand how all the components of the ToC feed into a lifecycle that can change over time, rather than in a linear model. The ToC needs to reflect the fact that the ISCF is envisioned to evolve over time
- The ToC needs to better reflect the work that is being done to leverage private sector investment
- There are other external factors that influence/enable the outputs, outcomes and impacts the ISCF seeks to realise – these should be captured within the ToC. A spheres-of-influence framework may be a useful way to demonstrate this
- The impacts section is broadly correct but requires more work to make it specific to the Grand Challenges (see discussion under impacts below)
- The five ISCF objectives, currently placed together as mid-term outcomes within the ToC, do not feel as if they are in the right place. These are more like objectives that informed the activities and outputs of the Fund

### F.3. Impacts

Overall



- Some of the things currently within the impacts section could be moved to outputs. The focus of the impacts section should be on the societal-level benefits delivered by the ISCF. For example, new products and services are more short-term outcomes than impacts. The impact comes from scaling-up these innovations to the societal level
- Items like productivity, national and regional economic growth probably do belong under impacts

#### **Using the Grand Challenges as the basis for impacts**

- The strawman ToC linked the impacts of the ISCF to the Grand Challenge missions of the UK Industrial Strategy
- One possible way of restructuring the impacts section would be to focus on the more specific societal-level benefits that will be delivered by the ISCF. This could potentially still incorporate reference to the Grand Challenge missions but would also highlight the more specific expected impacts of the ISCF in relation to these, and be clearer about overlaps.
- While some of the specific benefits delivered by the Fund will sit nicely under the Grand Challenges, some may not. This reflects the fact that the ISCF Challenges weren't designed specifically to achieve the Grand Challenge missions (though there is overlap), and that the link to the Grand Challenges is not always explicit.

#### **Treatment of place-based impacts/levelling up**

- The ToC could include more on benefits of the ISCF in terms of regional/place-based growth (levelling up). However, there was also debate about whether this should be identified as a formal impact within the ToC.
- On the one hand, there is interest in place-based impact of the ISCF, e.g. has it generated jobs in specific parts of the country or boosted regional specialism? On the other hand, it may not be appropriate to put these sorts of things under impacts because levelling-up was not an objective of the ISCF when it was established.
- As a compromise, it could be that a reference to levelling up sits somewhere on ToC (or within the accompanying narrative) but is not identified as an impact of the Fund. This would reflect the fact that place has become an influence on the ISCF but is not part of why it was initially set up.

#### **Reflecting potential tensions between impacts**

- There may be scope to recognise where there are potential conflicts between envisioned impacts of the ISCF. For example, the ToC emphasises productivity and job creation, but additional jobs could reduce measured productivity. It will be important to highlight any potential tensions in the narrative accompanying the ToC, and also to think about implications for definitions and measurement.

#### **Treatment of policy as an impact/outcome viz. policy as an input**

- At the moment, evidence-based policy is framed as an impact of the ISCF, but in some cases policy can be more of an input. For example, if you want to get drones to fly in the UK, you need to change the regulatory environment first (input).

### **High-skilled jobs**

- The strawman ToC has a focus on the creation of high-skilled jobs – is it only high-skilled jobs that we want to create? There may be merit in having this focus given links between high-skilled jobs and economic productivity, but what about other types of jobs?
- There is potentially a need for more nuanced explanation of what specifically is intended to be achieved in this respect

## **F.4. Outcomes**

### **Overall**

- Several of the items currently listed as impacts should be moved back to the outcomes section of the ToC, with impacts focusing instead on big societal-level impacts (see discussion above). For example, ‘new products, processes, services and approaches implemented delivering benefits to business and society’. This is better-placed under outcomes – the focus of the impacts should be on what we think the benefits will actually be.

### **Treatment of ISCF objectives (mid-term outcomes)**

- The five ISCF objectives do not sit well in their current position as mid-term outcomes. At present, they seem to create an obstacle to delineating what it is the ISCF actually does between short-term outcomes and impacts.
- These are the five objectives that ISCF set itself from the outset, and which influenced the way initial activities were undertaken
- While it was suggested that these five objectives could be extracted from the ToC and put more as contextual elements that influenced the inputs and activities of the Fund, it was also recognised that their inclusion within the ToC may be useful to enable measurement against the objectives. If kept in, it would be necessary to distribute the five objectives to the most relevant parts of the ToC.

### **Mid-term outcomes**

- The inclusion of mid-term outcomes is useful because it presents an opportunity to demonstrate what the ISCF will contribute beyond outputs and short-term outcomes that will lead to the envisioned impacts
- One thing that the mid-term outcomes should cover are factors between ‘technological readiness’ (output or short-term outcome) and societal-level diffusion/adoption and impact, i.e. factors that enable societal adoption of technologies or innovations, and thereby influence the capacity of those technologies or innovations to achieve impacts. Some of these factors are exogenous, but some are things over which the Challenges and the Fund seek to influence, for the example the overcoming

of regulatory barriers/development of evidence-based policy. In addition to highlighting those factors that the ISCF does seek to impact, it may also be worth recognising those more exogenous factors. Here, there was potential to incorporate a sphere of influences model into the ToC.

#### **What works in funding mission-oriented R&I**

- The ToC could more clearly incorporate an outcome on identifying what works in funding mission-oriented R&I. This will reflect envisioned learning from the ISCF's use of portfolio approach, its approach to deciding what to fund, and the Challenge focus.

## **F.5. Outputs**

#### **Building a more interconnected research ecosystem**

- A key envisioned output and outcome of the ISCF is to create a more interconnected R&I system that has more specific/coordinated plan in terms of how Challenges are addressed. The aim is to increase propensity for people to interact with people they wouldn't normally in order to do research to address the Challenges.
- The focus on building an interconnected research system could be brought out more strongly, within both outputs and outcomes

#### **Monitoring and evaluation**

- Monitoring and evaluation is currently an activity. There may be scope to include an output that covers the results of this activity, which could then link to the 'what works' outcome discussed above.

## **F.6. Activities**

#### **Inclusion of other activities**

- We could try to incorporate more Fund-level activities, over and above the Challenge-level activities currently reflected. Relevant activities that are perhaps not adequately captured include:
  - The activities undertaken to select the Challenges in the first place, which was a key activity for the Fund. There is also a potential feedback loop here, as the learning that was taken from the establishment of the first Challenges shaped inputs and activities relating to selection of later Challenges.
  - There could also be a more on activities regarding the process of prioritising and selecting work within the Challenges
  - Work developing the framework for benefit mapping
  - Coordinating and making sure that the different strands are on track; there's also a coordination element, i.e. ensuring that the challenge is 'on track'
  - Catalysing co-investment from industry

- Proactive engagement of what's important to industry and respond to these demands
- Business support and support of SMEs

## F.7. Inputs

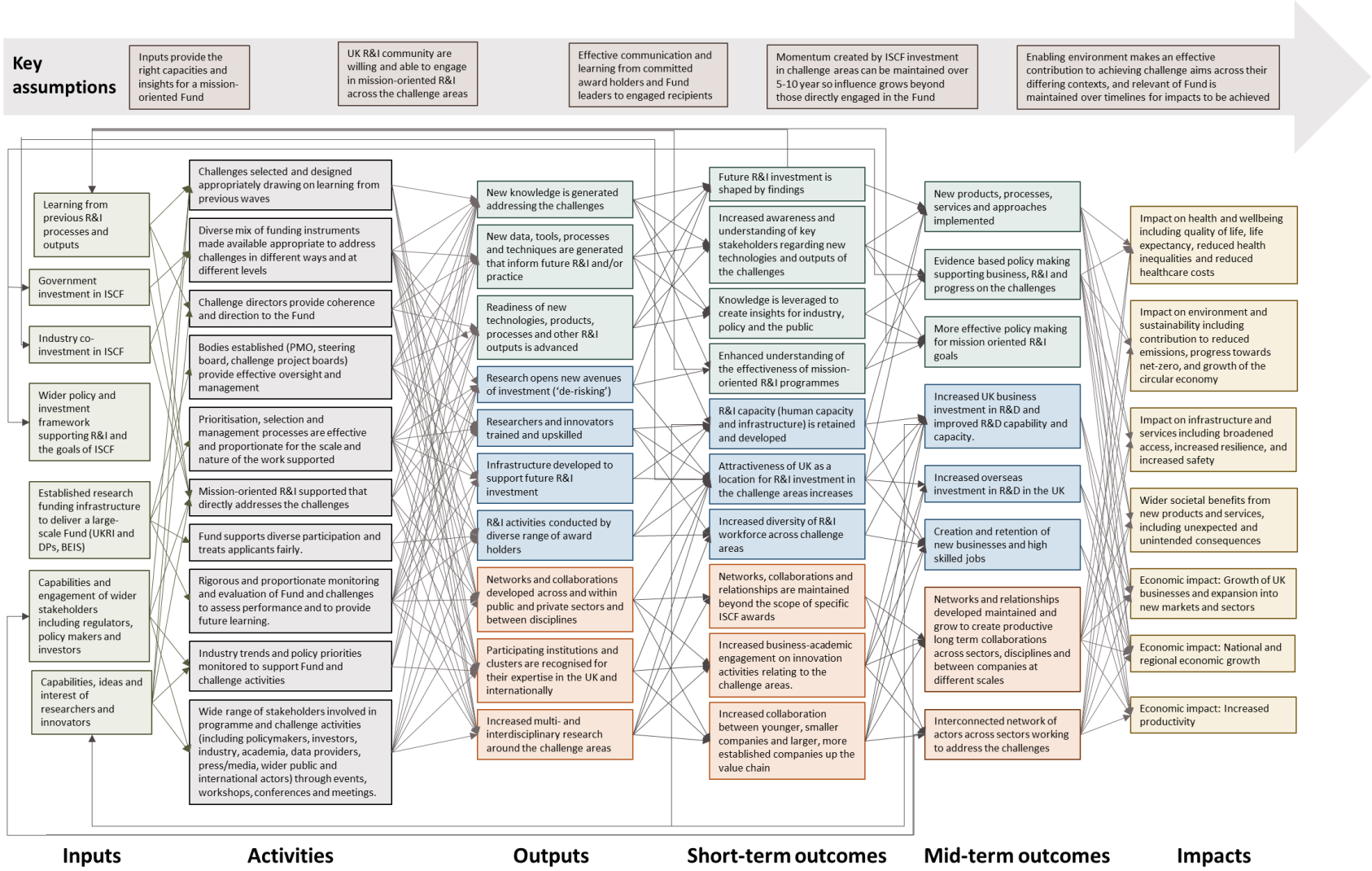
### Policy as an input

- Linked to the point above (see discussion under impacts), policy can be an input as well as an outcome/impact. This should be brought out more explicitly under inputs

## Annex G. ToC mapping of connections

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This annex provides an alternative presentation of the ToC logic model, mapping the connections between different aspects of the logic model including feedback loops. This is intended to illustrate the thinking in the development of the ToC and may be of use to internal stakeholders.



# Annex H. Draft privacy notice and topic guide for key informant interviews

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## H.1. Overview

This annex presents a draft privacy notice for the key informant interviews to be conducted in phase 4 of the evaluation. The annex also includes a draft interview topic guide covering both process and impact evaluation questions.

## H.2. Privacy notice for key informant interviews

### About the project

RAND Europe was commissioned by UKRI to complete an evaluation of the Industrial Strategy Challenge Fund (ISCF). As part of this study, RAND Europe is conducting a number of interviews with key stakeholders to gain perspectives on how the ISCF portfolio has been delivered, the links between impacts and processes, and key lessons learned.

### Who are we?

[RAND Europe](#) is a not-for-profit research institute based in Cambridge whose mission is to help improve policy and decision-making through research and analysis. Our mission is realised by undertaking objective, balanced and relevant research and analysis. We work in partnership with our clients and collaboratively with others. More information on RAND Europe, our past and current projects, and researchers can be found on [our website](#).

### What data do we collect?

You have been contacted as a stakeholder central to the management and delivery of the ISCF. In the interview, we will collect your views on ISCF strategy, delivery, engagement with a wide range of stakeholders, as well as cross-cutting issues. The information you provide during this interview will be associated with your name in a secure repository only accessible to RAND Europe.

### How do we collect the data?

A researcher from RAND Europe will carry out an interview with you over MS Teams or equivalent videoconferencing tool. The researcher will take notes during the interview and/or record your views onto secure digital media.

### Why are we collecting it?

Your views will be used to help RAND Europe and UKRI better understand ISCF processes at a Fund-level, and inform potential improvements.

**What is the legal basis for processing your data?**

We believe it is in our legitimate interest to process your responses as the responses will be aggregated and not identified. We believe that you would consider it is reasonable to expect that your contact details are used to communicate and organise the research and that views are analysed and summarised to meet the research aims. As your views will not be publicly associated with your personal data there will be no effect on your rights and freedoms.

**What do we use the data for?**

Your contact details are solely used to organise your interview, store your response against your identifiers, and re-contact you to get clarifications if needed. Your responses will be used for analysis and your personal data will not be associated with the responses thereafter without your permission. Any use of direct quotations will not identify you or be attributed to you.

**How do we share the data?**

Data will be analysed and used to inform a report which will be published. Any quotes will be presented anonymously. No personal data will be shared with any other party.

**How do we keep your data secure?**

RAND Europe has implemented a company-wide Information Security Management System (ISMS). RAND Europe is accredited for ISO 27001 certification and Cyber Essentials Plus. We have a senior management team that supports the continuous review and improvement of the company ISMS. Key controls RAND Europe has implemented include:

- An Information Security Risk Assessment Process that assesses the business harm likely to result from a security failure and the realistic likelihood of such a failure occurring in the light of prevailing threats and vulnerabilities, and controls currently implemented
- An Information Classification and Handling Policy including compliance with regulations under the Data Protection Act to protect client, partner, supplier, our own and personal employee information which is not in the public domain
- A Business Continuity Plan to counteract interruptions to business activities and to protect critical business processes from the effects of major failures or disasters
- Defined security-controlled perimeters and access to controlled offices and facilities to prevent unauthorised access, damage and interference to business premises and information and data that might be held there
- Mandatory Information security awareness guidance for all company employees
- Background screening of all company employees

Data will be held on a server located in RAND Europe's Cambridge, UK office. Backups taken for disaster recovery purposes will be encrypted and stored in a secure offline site.

**How long do we keep your data?**



The data linking your identity to the interview will be stored for three months after completion of the project. After this, it will be destroyed.

#### **What choices do you have in our use of your data?**

Your choices over processing of your data are set out in the following section of your rights below.

#### **Your rights over the processing**

RAND Europe operates in accordance with EU law including GDPR. You are provided with certain rights that you may have the right to exercise through us. In summary those rights are:

- To access, correct or erase your personal data
- To object to the processing of your personal data

If you wish to exercise any of these rights, please use the contact details below.

#### **How do you contact us?**

Please contact the RAND Europe Data Protection Officer by email at [REdpo@randeurope.org](mailto:REdpo@randeurope.org) or in writing to Data Protection Officer, RAND Europe, Westbrook Centre, Milton Road, Cambridge, CB4 1YG, UK.

### **H.3. Key informant interview topic guide**

Thank you for agreeing to participate in an interview as part of our evaluation of the ISCF. The purpose of this interview is to inform our understanding and analysis of ISCF processes, from strategic thinking to management and delivery. The interview will also address some themes relating to our impact evaluation of the ISCF.

#### **H.3.1. Background**

Areas to be covered:

- Your role within ISCF and key responsibilities
- The Challenges and personnel with whom you most regularly interact

#### **H.3.2. ISCF processes**

##### **Strategy**

Areas to be covered:

- The role of the Challenge Director in setting and delivering priorities
- The coherence of ISCF funding instruments
- Learning that took place across, and between, Challenge waves
- The role of ISCF governance, in particular its adaptability to a changing policy landscape and socioeconomic 'shocks'

##### **Delivery**

Areas to be covered:

- The suitability of ISCF funding instruments to meet Industrial Strategy objectives
- The effective and proportionate management of the ISCF
- The use and efficacy of monitoring and evaluation for evidence-based policymaking

### **Wider engagement**

Areas to be covered:

- Involvement of wider stakeholders in Challenge development and activities
- Industrial commitments and engagements

### **Cross-cutting themes**

Areas to be covered:

- Diversity and fairness of the ISCF regarding gender, place, and race
- Facilitators and barriers to implementation and delivery of the ISCF

### **H.3.3. ISCF impacts**

Areas to be covered:

- Impact (if any) on stakeholder awareness and understanding regarding new outputs addressing the Challenges
- Examples (if any) of the adoption of ISCF outputs
- Impact (if any) on evidence-based policymaking surrounding the Challenges
- Contribution (if any) to understanding of the effectiveness of mission-oriented R&I programmes
- Extent (if at all) to which the ISCF has opened up new avenues of investment, including overseas investment
- The geographic spread of ISCF investment
- Contribution (if any) to infrastructure to support future R&I investment
- Impact (if any) on the attraction of additional talent and Challenge-associated skills into the UK
- Contribution (if any) to EDI
- Contribution (if any) to the creation high-skilled jobs
- Impact (if any) on business-academic engagement relating to Challenge areas
- Extent (if at all) to which the ISCF has increased collaboration between businesses including across the value chain

- Extent to which institutions and clusters have been recognised for their expertise

# Annex I. Indicative matrix for longlisting of case study examples

Name of example (as assigned by the evaluation team)	Description of potential case study example	Associated Challenge(s)	Type of impact (societal/economic)	Specific type of societal impact achieved (health and wellbeing; environment and sustainability; infrastructure and services; wider societal benefits) (as applicable)	Specific type of economic impact achieved (growth of UK business; national and regional economic growth; increased productivity)	Evidence of new knowledge or innovation created	Evidence that capacity and investment has been increased	Evidence that networks and a more connected ecosystem have been created	Evidence of wider societal-level impacts	Evidence of potential wider societal-level impact	Evidence that outputs, outcomes, impacts link to ISCF strategy	Evidence that outputs, outcomes, impacts link to ISCF delivery	Evidence that outputs, outcomes, impacts link to wider engagement fostered by the ISCF
Example 1	<i>Description</i>	XX Challenge	Societal	Health	N/A	✓	✓	✓			✓	✓	✓

## Annex J. Theory based evaluation methods

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This annex provides an overview of different potential theory-based evaluation methods that could have been used, their pros and cons (based on the Magenta Book, Annex A), and our assessment of their suitability for use in the ISCF. Based on this analysis, we have decided to use a contribution analysis-based approach.

Analytical method	Pros	Cons	Assessment of suitability for evaluation of ISCF
Qualitative Comparative Analysis (QCA)	<ul style="list-style-type: none"> <li>• A pragmatic method that can identify groups of causal factors that can reasonably be used in post-hoc evaluation</li> <li>• QCA works best when data on all the cases of interest are available and the number of cases is neither too small nor too large: around 10 to 50 cases</li> </ul>	<ul style="list-style-type: none"> <li>• It can be used with larger numbers of cases, however, depth of understanding will be necessarily reduced</li> <li>• It may be difficult to determine which cases represent more 'success' or 'failure' than others</li> </ul>	Not well suited: Measures of success that are universal to different Challenges may be hard to establish, and best suited to comparison of equivalent interventions in different contexts which is not quite appropriate here.
Realist evaluation	<ul style="list-style-type: none"> <li>•Refines public policy theory through the testing of underlying theories of how social systems work</li> <li>•Provides a method to undertake impact evaluation when a counterfactual is not feasible</li> <li>•Builds the wider evidence base of an area by providing a framework for testing hypotheses that may be relevant beyond a particular intervention</li> <li>•Is method-blind in the sense that RE is an evaluation design that can employ a variety of analytical methods with it</li> </ul>	<ul style="list-style-type: none"> <li>•Is time consuming and resource intensive for both commissioner and contractor</li> <li>•Requires subject-matter expertise to undertake</li> <li>•Depending on the design of the evaluation, it may not provide an average net effect of the intervention</li> </ul>	Not well suited: Helpful to evaluate pilot programmes that will be scaled up as it focuses to a greater extent on why and how a programme works, rather than the direct links between a programme and outcomes
Process tracing	<ul style="list-style-type: none"> <li>• Process tracing is a practical method for understanding and testing causal hypothesis in 'real world' situations that can be used in ex-post evaluation of a single case</li> </ul>	<ul style="list-style-type: none"> <li>• This method must be used with rigour to prevent inferential errors; alternative explanations must be carefully considered. Equifinality (the support of one causal mechanism may not preclude others) should also be considered</li> </ul>	Not well suited: Useful for testing causal mechanisms but for a single case rather than different Challenges

<p>Contribution analysis</p>	<ul style="list-style-type: none"> <li>Useful where there is limited scope or opportunity to affect roll-out of a programme (to allow for experimental methods)</li> <li>Able to confirm or revise a ToC</li> </ul>	<ul style="list-style-type: none"> <li>The quality of the eventual analysis and contribution claim is dependent on the quality of the thinking about the attribution problem and theory of change</li> <li>Contribution analysis does not provide definitive proof that the intervention has had a causal effect, but rather an evidenced logical line of reasoning which gives some level of confidence of an intervention's contribution</li> <li>Works on average effects, therefore, should not be used if there is a large degree of variance about how a programme has been implemented or an expectation of different outcomes for different groups</li> </ul>	<p>Well suited: Provides an effective and structured method for synthesising different types of data, collected across multiple domains, jurisdictions, time points, and stakeholders, into a coherent narrative regarding a programme's contribution. This is well-suited to the structure of the ISCF, comprised as it is of diverse Challenges and stakeholder groups, including across different sectors, fields, contexts and implementation timescales</p>
<p>Bayesian updating</p>	<ul style="list-style-type: none"> <li>Useful where contribution claims cannot be directly observed and measured, making them difficult to test, particularly in complex settings</li> <li>Useful where there is a broad range of evidence of varying quality available</li> <li>Can build consensus for contribution claims as stakeholders can be included in the judging the strength of evidence supporting the contribution claim</li> </ul>	<ul style="list-style-type: none"> <li>The reliance on formulas and probabilities can make the findings more opaque to the researcher and research users</li> <li>It is easy for the scale of the exercise to escalate, so parameters need to be set early on</li> <li>The rigour of the method depends on the robustness of the probabilities</li> <li>Evidence can support both a contribution claim and an opposing theory</li> </ul>	<p>Moderately suited: Requires generating formulas and probabilities early on in a programme which is not appropriate for the ISCF programme which has already started</p>

Contribution tracing	<ul style="list-style-type: none"> <li>• Points to what evidence to look for and what it means in relation to the claim. It only uses evidence with the 'highest probative value', i.e. evidence with the power to increase or decrease confidence in a specific claim, so time is not wasted asking other questions</li> <li>• Specificity of the contribution claim increases the conceptual precision, clarity and quality of ToCs</li> <li>• Minimises confirmation bias by using 'critical friends' during the contribution testing phase, which represent other plausible explanations of the observable change</li> <li>• Participatory and collaborative</li> </ul>	<ul style="list-style-type: none"> <li>• Not so useful in answering how a programme compares with other programmes</li> <li>• Schedule of undertaking needs to be right – the intervention needs to have been going for long enough for the 'traces' to be visible</li> <li>• Must spend equal time and resources on exploring other potential causes to ensure all views appropriately considered</li> </ul>	Not well suited: Requires a programme or intervention to have been going for enough time that 'traces' are visible, which is challenging for the ISCF for which many impacts will not have occurred yet
Most significant change	<ul style="list-style-type: none"> <li>• Builds understanding and focus across teams and stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• Is time consuming and resource intensive – needs robust facilitation</li> </ul>	Moderately suited: Good participatory approach, but best used where it is not possible to predict in any detail or with any certainty what the outcomes will be. Whilst outcomes for the ISCF certainly do have some uncertainty, Challenges do have at least clear and predetermined goals
Outcome harvesting	<ul style="list-style-type: none"> <li>• Useful where participation is easily fostered</li> <li>• Beneficial where stakeholders are disparate; helps to render views visible to all</li> </ul>	<ul style="list-style-type: none"> <li>• Resource intensive</li> </ul>	Moderately suited: Has a greater focus on outcomes rather than activities



<p>Simulation modelling</p>	<ul style="list-style-type: none"> <li>• Provides a systematic method for evaluation of a complex intervention</li> <li>• Enables estimation of the size of future long-term outcomes or unobservable outcomes which cannot be otherwise accounted for</li> </ul>	<ul style="list-style-type: none"> <li>• Strength is dependent on quality of data, assumptions and simulation logic</li> <li>• Some models use specialist software, which may be costly</li> <li>• May be time consuming and expensive to construct accurate models</li> </ul>	<p>Not well suited: Challenging to collect comparable 'endpoints' for the different ISCF Challenges</p>
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## Annex K. Initial assessment of anticipated strength of evidence for the impact evaluation

This annex provides an initial assessment of impact evaluation data gaps in the form of a ‘RAG’ (red–amber–green) table. For each impact evaluation question, the table provides the evaluation team’s subjective assessment (red, amber or green) of the anticipated strength of evidence from both the Challenge-level evaluations (phase 3) and the primary data collection/review of wider data sources (phase 4), with comments on anticipated data gaps where appropriate. In some cases, the table also outlines potential additional actions that might be taken to address data gaps, pending further discussion between the evaluation team and UKRI.

Evaluation question	Anticipated strength of evidence from Challenge-level evaluations (RAG)	Anticipated strength of evidence from primary data collection/review of wider data sources (RAG)	Comments on anticipated data gaps	Potential additional actions to address data gaps
Creating knowledge and innovation pathways				
1. What has been the contribution of the ISCF to new knowledge addressing the Challenges, both within the UK and internationally (publications)?	Green	Yellow	At Fund-level, analysis will be limited to number of publications and coverage across Challenges.	If desired by UKRI, additional bibliometric analysis could be incorporated. However, this would involve additional costs.
2. What has been the contribution of the ISCF to new knowledge addressing the Challenges, both within the UK and internationally (other)? (Datasets, services, business models, outputs)	Green	Yellow	Anticipated that significant evidence on other (non-publication) outputs will be available at Fund-level, but that lack of consistent reporting may mean there are limitations to the Fund-level analysis.	

Evaluation of the Industrial Strategy Challenge Fund

3. To what extent has the ISCF advanced the readiness of new technologies, products and processes?			Anticipated that significant evidence on patents and other IP will be available at Fund-level, but lack of consistent reporting may mean there are limitations to the Fund-level analysis.	Scoping work to consider the potential use of Lens and/or Orbis data for patent analysis will be undertaken during the baselining phase of the evaluation.
4. 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?			At Challenge-level and Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
5. To what extent have ISCF outputs (technologies, products, processes, services, approaches, etc.) been implemented/adopted within society?			At Challenge-level and Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
6. To what extent has the ISCF contributed to evidence-based policymaking surrounding the Challenges?			At Challenge-level and Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
7. 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?			Limited information anticipated from Challenge-level evaluations. At Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
Capacity and investment				
1. To what extent has the ISCF increased UK businesses' investment in R&D?				Scoping work conducted during baseline phase will consider the potential use of Beauhurst and/or Crunchbase for data on UK businesses investment in ISCF-supported companies.
2. To what extent has the ISCF increased overseas investment in R&D in the UK?			Extent to which Challenge-level evaluations report on overseas investment is inconsistent. At Fund-level, analysis will rely primarily on	Scoping work conducted during baseline phase will consider the potential use of Beauhurst and/or Crunchbase for data on

			qualitative assessment (e.g. stakeholder perceptions).	overseas investment in ISCF-supported companies.
3. 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?			While the amount of investment enabled through the ISCF can be measured and compared to the 2.4% target, it will not be possible to know precisely how much of this investment is 'additional'.	
4. To what extent has research supported by the ISCF opened up new avenues of investment (de-risking)?			Extent to which Challenge-level evaluations report on further investment is inconsistent. At Fund-level, analysis will depend upon availability of consistent data on follow-on funding/investment.	Scoping work conducted during baseline phase will consider the potential use of Beauhurst and/or Crunchbase for data on follow-on (post-ISCF) investment in ISCF-supported companies.
5. While the ISCF is place-agnostic, to what extent have the Fund's investment and activities been widely distributed across the UK?			Limited information anticipated from Challenge-level evaluations.	
6. How and to what extent has the ISCF increased individual capabilities and capacities both in research and innovation?			Anticipated that significant evidence will be available at Fund-level, but that lack of consistent reporting may prevent identification of a specific number of personnel trained.	If supported by UKRI, a direct ad-hoc request to the Challenges may enable us to better estimate the number of personnel trained.
7. How and to what extent has the ISCF contributed to improved infrastructure to support future R&I investment?			Anticipated that Challenge-level evidence will be varied depending on interpretation of infrastructure. At Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
8. To what extent has the ISCF attracted additional talent and Challenge-associated skills into the UK?			At Challenge-level and Fund-level, analysis will rely primarily on qualitative assessment (e.g. stakeholder perceptions). At Fund-	

			level, data on number of non-UK academics working in Challenge sectors will also be used as proxy.	
9. How has the ISCF contributed to EDI?			Extent to which Challenge-level evaluations report on EDI is inconsistent.	
10. To what extent has the ISCF contributed to the creation and retention of new business and high-skilled jobs?				
Connected innovation ecosystem				
1. To what extent has the ISCF increased MIDRI research around the Challenge areas?			At Challenge-level and Fund-level, analysis of MIDRI will focus on projects only (and not publications).	If desired by UKRI, we could consider alternative approaches to measuring MIDRI through bibliometric analysis. However, this would involve additional costs.
2. To what extent has the ISCF increased business-academic engagement on innovation activities relating to the Challenge areas?				
3. To what extent has the ISCF increased collaboration between businesses including between younger, smaller companies and larger, more established companies up the value chain?				
4. To what extent have institutions and clusters participating in the ISCF Challenges been recognised for their expertise within the UK and internationally?			Extent to which Challenge-level evaluations report on awards and recognition is inconsistent. Anticipated that significant evidence on awards and recognition will be available at Fund-level, but that lack of consistent reporting may prevent identification of a specific number.	
Societal impact				

1. 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?			Extent to which Challenge-level evaluations report on health impacts is inconsistent. At Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
2. To what extent has the ISCF contributed environmental and sustainability benefits, including contribution to reduced emissions, progress towards net zero, and growth of the circular economy?			Extent to which Challenge-level evaluations report on environmental impacts is inconsistent. At Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
3. To what extent has the ISCF contributed benefits to infrastructure and services including broadened access, increased resilience, and increased safety?			Extent to which Challenge-level evaluations report on infrastructure and services impacts is inconsistent. At Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
4. To what extent has the ISCF contributed wider societal benefits, including unexpected and unintended consequences?			Limited information anticipated from Challenge-level evaluations. At Fund-level, analysis will rely primarily on qualitative assessment (e.g. examples and stakeholder perceptions).	
Economic impact				
1. 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?			Fund-level econometric analysis will provide insights on growth of UK businesses but limited information on creation of new markets or growth of UK's market share.	
2. What has been the increase in GVA (including the creation of new products and services in relevant sectors and/or the creation of new markets)?				

<p>3. While the ISCF is place-agnostic, to what extent have the economic impacts of the ISCF been the widely distributed across the UK?</p>			<p>Extent to which Challenge-level evaluations report on place impact is inconsistent.</p>	
<p>4. What has been the productivity change (capital, labour or combined)?</p>			<p>Extent to which Challenge-level evaluations report on productivity changes is inconsistent. At Fund-level, analysis of productivity change will focus on turnover per worker for ISCF-funded businesses and the GVA impact of the ISCF per worker.</p>	
<p>Value for money</p>				
<p>1. To what extent does the ISCF represent value for money?</p>			<p>Approach to measuring VfM across the Challenge-level evaluations is varied. Not all aspects of the 'value' of the ISCF can be quantified so this will be a mixed qualitative and quantitative assessment.</p>	

## Annex L. Initial consideration of wider databases

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This annex presents a summary of initial consideration of wider databases by the evaluation team during the development of this evaluation framework. This initial consideration has identified four databases – Lens, Orbis, Beauhurst and Crunchbase – for further scoping during the baselining stage. Our prior expectation is that these datasets will have only limited value, as much of the data will not correspond closely enough to meaningful indicators, and coverage may be limited due to narrow criteria for inclusion. In the case of Beauhurst and Crunchbase, the main variables relate to companies’ raising funds rather than R&D investment per se. In the case of Lens and Orbis, our understanding is that while these datasets contain information on patents, if this is just a measure of number of filings, this will serve as a poor proxy for R&D activity. And while the datasets may contain further financial variables, these will be derived from published filings, and so reporting thresholds will entail poor coverage, which again limits the usefulness relative to the core ONS data. Nevertheless, a more thorough investigation on these points is warranted.

The table below includes summary comments relating to each database and further detail on the focus of this scoping work where this will be conducted.

Name of database	Focus	Summary comments	Further scoping work to be conducted during baselining phase?	Focus of further scoping work (if applicable)
Lens	Publication and patent data	Lens contains large datasets on both publications and patents. However, initial piloting of the database has demonstrated that it will be difficult to identify ISCF portfolio. Not all publications identify the ISCF (or the relevant ISCF Challenge) as a funding source, making it difficult to use the database to identify a set of publications linked	Yes	<ul style="list-style-type: none"> <li>The coverage of ISCF-supported organisations within the Lens database</li> <li>The feasibility of distinguishing between patents resulting from ISCF-</li> </ul>



		to the Fund, which could then be analysed. If such an analysis were desired by UKRI, a dedicated bibliometric database (e.g. Web of Science) would be more appropriate. For patents, Lens contains data on patent applications by organisation that could be used to analyse patent outputs of ISCF-supported organisations (academic institutions and companies).		funded activities and other patents <ul style="list-style-type: none"> <li>• The potential use of Lens for baselining of patent activity at a sectoral level for sectors relevant to ISCF Challenges</li> </ul>
Orbis	Company data (includes patent data)	Company level data in Orbis includes patent data. The database could be used to analyse patent outputs of ISCF-supported companies.	Yes	<ul style="list-style-type: none"> <li>• The coverage of ISCF-supported companies within Orbis</li> <li>• The feasibility of distinguishing between patents resulting from ISCF-funded activities and other patents</li> <li>• The potential use of Orbis for baselining of patent activity at a sectoral level for sectors relevant to ISCF Challenges</li> </ul>
Crunchbase	Company data	Company-level data collected in Crunchbase could be used to track investment in ISCF-supported companies, including investment of UK companies and overseas investment. This is likely to be data on investment in the companies generally, rather than investment in R&D specifically.	Yes	<ul style="list-style-type: none"> <li>• The coverage of ISCF-supported companies within Crunchbase</li> <li>• The granularity of investment data and applications to our evaluation indicators (e.g. overseas investment)</li> <li>• The potential use of Crunchbase for baselining of investment activity at a sectoral level for sectors relevant to ISCF Challenges</li> </ul>

Beahurst	Company data	Company-level data collected in Beahurst could also be used to track investment in ISCF-supported companies, including investment of UK companies and overseas investment. As with Beahurst, this is likely to be data on investment in the companies generally, rather than investment in R&D specifically. While providing broadly the same data as Crunchbase, Beahurst is more expensive. This would make Crunchbase the preferable option, minimising impact on the overall evaluation budget. However, further scoping will also help confirm the extent to which ISCF-supported companies are represented within the two datasets.	Yes	<ul style="list-style-type: none"> <li>• The coverage of ISCF-supported companies within Beahurst</li> <li>• The granularity of investment data and applications to our evaluation indicators (e.g. overseas investment)</li> <li>• The potential use of Beahurst for baselining of investment activity at a sectoral level for sectors relevant to ISCF Challenges</li> </ul>
Pitchbook	Company data	Pitchbook covers broadly similar data to Crunchbase and Beahurst, and is provided at a higher cost, which could have implications for other aspects of the evaluation. There is also less experience of using Pitchbook within the evaluation team. Given these factors, we will not consider Pitchbook as part of our further scoping work.	No	N/A