

Commissioning Letter

LONDON ECONOMICS LIMITED
Somerset House,
New Wing,
Strand,
London,
WC2R 1LA

Tuesday, 02 April 2019

Dear [REDACTED]

**BEIS Research and Evaluation Framework Agreement – Lot 3
An independent impact evaluation of nuclear fusion research
at the Culham Centre for Fusion Energy
CR19025**

Thank you for your response to the Specification for the above commission by the Department for Business, Energy and Industrial Strategy (BEIS) (the Customer) through the BIS Research and Evaluation Framework dated 2 January 2016 between (1) Secretary of State for Business, Innovation and Skills; and (2) London Economics Limited (the Framework Agreement).

Annexes: A. Tender dated 15th March 2019
 B. Specification for An independent impact evaluation of nuclear fusion research at the Culham Centre for Fusion Energy

The Department for Business, Energy and Industrial Strategy (BEIS) accepts your Tender (Annex A), submitted in response to our Specification (Annex B).

The Call-Off Terms and Conditions for this Contract are those set out in Schedule 5 to the Framework.

The agreed total charges for this assignment are **£ 49,137.50** exclusive of VAT which should be added at the prevailing rate, as detailed below;

SOURCING REFERENCE:	CR19025
SOURCING DOCUMENT TITLE:	An independent impact evaluation of nuclear fusion research at the Culham Centre for Fusion Energy
BIDDER NAME	London Economics

Please note that the staff costs in section 1 cell D27 should equal the staff costs outlined in section 2. Section 2 provides further detail around the project team and the distribution of staff days.

The highest cost for evaluation is the total Cost (ex VAT) provided in Section 1 (cell D27). The total cost is the total staff costs (ex VAT) and the total Travel and Subsistence, Overhead costs, cost of production of materials and small costs.

Please complete the shaded yellow sections only.

Section 1: Total Project Costs (Summary)

Objective	Number of Days	Total Staff Cost Per Objective (ex VAT)	Total Cost (Ex VAT)
1. Desk based Research			
2. Data Collection/Compilation consisting of			
2.1. In-depth f-2-f interviews			
2.2. telephone interviews			
2.3. On-line survey			
2.4. Focus Groups			
2.5. Case Studies			
2.6 Others (if applicable, please specify)			
3. Drafting			
4. Analysis			
5. Project management			
6. Meetings			
7. Other Costs (please specify)			
TOTAL			

Section 2: Total Staff Costs (Please complete)

Job Title	Standard Rate/Fees excluding VAT (£/Day)	Discounted Rate/Fees excluding VAT (£/Day)	Objective Area (Please Select)	Number of Days	Travel and Subsistence, Overhead costs, cost of production of materials and any/all costs associated with the delivery of the project (ex VAT)	Total Staff Cost (ex VAT)	Total Cost (ex VAT)
Partner							
Partner							
Partner							
Partner							
Partner							
Senior Consultant							
Senior Consultant							
Senior Consultant							
Senior Consultant							
Senior Consultant							
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Consultant							
Consultant							
Director							
Associate							
Associate							
Associate							
Associate							
Associate							
Associate							
Associate							
Junior							
Junior							
Junior							
Junior							
Junior							
s group venue hire 1/2 day and provision of refresh-							

TOTAL STAFF COSTS

Notes: Version 1.2

Day rate is for 8 hr day.
Half day rate is for 4 hrs.

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The agreed invoice schedule is as follows:

- 30% on delivery of the interim report June 2019
- 30% on delivery of draft report Aug 2019
- 40% once the final report is completed Sept 2019

All invoices should be sent to should be sent to finance@services.ukpbs.co.uk or Billingham (UKPBS, Queensway House, West Precinct, Billingham, TS23 2NF) A copy of the invoice should be sent to [REDACTED]

You are reminded that any Customer Intellectual Property Rights provided in order to perform the Services will remain the property of the Customer. The following deliverables have been agreed:

The Services Commencement Date is Wednesday, 3rd April 2019

The Completion date is Monday, 16th September 2019

The Contract may be terminated for convenience by giving 30 days' notice in accordance with clause 38 of the Call-off Terms and Conditions.

Your invoice(s) for this work must include the following information:
Commission number: CR19025

The Authorised Representative for this Commission will be [REDACTED] who can be contacted at [REDACTED]

Until the date of publication, findings from all Project outputs shall be treated as confidential. Findings shall not be released to the press or disseminated in any way or at any time prior to publication without approval of the Department.

This clause applies at all times prior to publication of the final report. Where the Contractor wishes to issue a Press Notice or other publicity material containing findings from the Project, notification of plans, including timing and drafts of planned releases shall be submitted by the Contractor to the Project Manager at least one week before the intended date of release and before any agreement is made with press or other external audiences, to allow the Department time to comment on factual accuracy. All Press Notices released by the Department or the Contractor shall state the full title of the research report, and include a hyperlink to the Department's research web pages, and any other web pages as relevant, to access the publication/s.

This clause applies at all times prior to publication of the final report and within one month from the date of publication. Where the Contractor wishes to present findings from the Project in the public domain, for example at conferences, seminars, or in journal articles, the Contractor shall notify the Project Manager before any agreement is made with external audiences, to allow the Department time to consider the request. The Contractor shall only present findings that will already be in the public domain at the time of presentation, unless otherwise agreed with the Department.

Congratulations on your success in being selected to undertake this Commission.

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Yours sincerely

[Redacted]

UK Shared Business Services Ltd

BY SIGNING AND RETURNING THIS COMMISSIONING LETTER THE SERVICE PROVIDER AGREES to enter a legally binding contract with the Customer to provide to the Customer the Services specified in this Commissioning Letter and Annexes incorporating the rights and obligations in the Call-off Terms and Conditions set out in the Framework Agreement.

Department for Business, Energy and Industrial Strategy (BEIS)

Name and Title	[Redacted]
Signature	[Redacted]
Date	04/04/2019

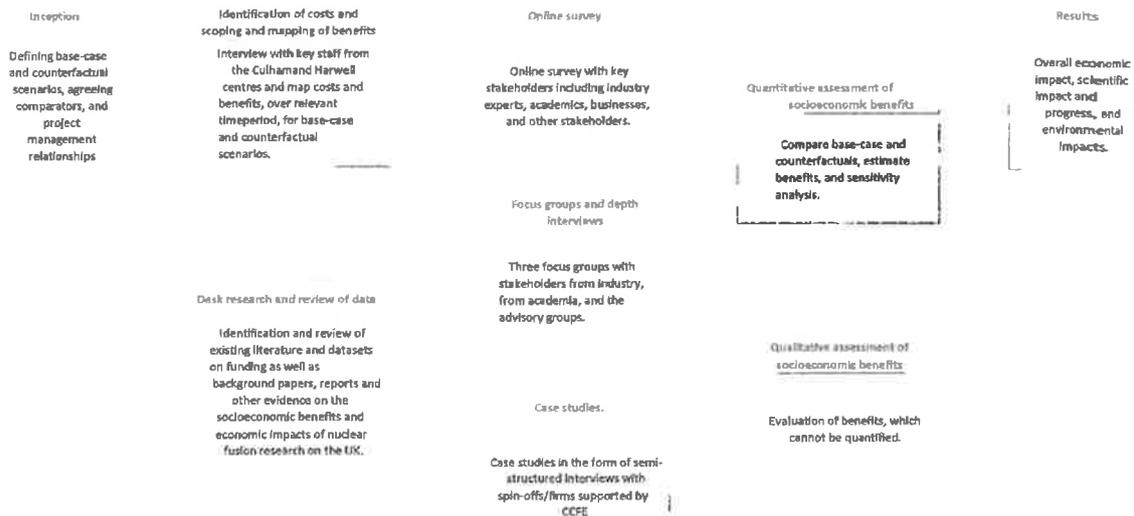
Signed on behalf of LONDON ECONOMICS LIMITED

Name and Title	[Redacted]
Signature	[Redacted]
Date	2nd April 2019

Annex A tender response

PROJ1.1: Approach / Methodology

This section sets out our proposed methodology for addressing the study requirements. It draws on our experience in undertaking a wide range of impact assessments (see PROJ1.3). We understand BEIS wishes to assess the public and private financial costs of the UK's nuclear fusion research as well as the impacts that UK nuclear fusion research has had on the UK. The approach must follow best practice socio-economic impact assessment set-out in the Green Book. The focus of the assessment on the socio-economic benefits of fusion research presents challenges for the assessment as some (or many) of the benefits will not have a market price (e.g. commercialisation of the final product). Therefore, we propose to use a multi-modal approach to the assessment drawing upon quantitative impacts where feasible and robustly justified and qualitative evidence. We build in significant time for engagement with BEIS, the Culham Centre for Fusion Energy (CCFE) and other key stakeholders. The figure below provides an overview of our proposed approach which follows best practice HMRC Green Book:



The outcome of the research will be a robust evidence base of the financial costs (both private and public) and the impact, on the UK, of the UK's nuclear fusion research programmes.

Defining the base-case and counterfactual scenarios

A key first step is to define the 'baseline' and 'counterfactual' scenarios which form the basis of the analysis. The socio-economic benefits and costs of the baseline scenario are assessed relative to the counterfactual.

BEIS wishes to understand the public and private financial costs and benefits of the UK's nuclear fusion research programme. These costs and benefits will form the **baseline scenario**.

Our proposal is to use the (hypothetical) scenario where there is no UK government money spent on nuclear fusion research. In this scenario, services that rely on government investment in nuclear fusion or on the outputs of nuclear fusion research that received this money are not provided. In particular, the Culham and Harwell centres would not have been opened.

This counterfactual is the most straightforward to apply and also provides the most natural interpretation of statements such as "The economic net benefit of nuclear fusion research on the UK, under the baseline scenario, is £Xm". Even if this scenario is considered not realistic in practice, it will **allow valuation of all benefits** associated with nuclear fusion research. This corresponds to the '**do nothing**' option recommended in the Treasury's 'Green Book'. However, we will discuss the counterfactual with BEIS at our proposed project initiation workshop and select the most appropriate counterfactual and baseline in consultation with BEIS.

To further substantiate and validate the counterfactual, the counterfactual will be explored in more detail with industry experts via the depth interviews and the online survey. In particular, these consultations will seek to answer questions such as (but not limited to): what might the research money have been spent on instead; how might the land for the Culham and Harwell centres have been used instead; and how would the fusion industry in the UK have looked like in this scenario. The specific questions to be asked will be discussed with BEIS before starting the consultation process.

Strand 1: Identifying the costs and scoping and mapping the benefits of the UK's nuclear fusion research

The first element of our approach involves identifying the costs and scoping and mapping the flow of costs and benefits of the UK's investments in nuclear fusion research and the research enabled by these investments. A systematic scoping and mapping of the flow of benefits and their links with i) each other and ii) the UK's investments in nuclear fusion research is critical for a comprehensive assessment of the costs and benefits of the UK's nuclear fusion research.

To facilitate this task we propose to first conduct an **extended project inception workshop** with BEIS and the internal steering group. We propose this meeting will take place in London and would last between 2 and 2.5 hours. The purpose of this initial workshop will be to refine our approach including the counterfactual and baseline plus any other scenarios that should be considered in the modelling. Further, to undertake an initial high-level mapping of the flow of costs and benefits of nuclear fusion research. The outcome of this meeting will be a first cut costs and benefits flow map. This mapping will then inform the stakeholder interviews and online survey design.

We will conduct **5 in-depth interviews** with key staff from the Culham and Harwell centres to acquire key data on spend on nuclear fusion research as well as the benefits and impacts that flow from this research. The interviews will also be used to identify other key stakeholders and beneficiaries for Strands 3, 4 and 5.

The initial list of topic areas to be discussed during the interviews includes as a minimum the questions listed in the ITQ; i.e.:

- What has been spent from public, private and overseas sources to date on nuclear fusion research and development in the UK?
- What has nuclear fusion research contributed to the UK Nuclear fusion research? (e.g. in terms of publications, numbers of PhDs/apprentices trained, and major scientific progress made)
- What evidence do you hold in relation to the scientific impact of nuclear fusion research in the UK, in terms of both progression towards the eventual commercialisation of nuclear fusion as an energy source, and the use of technologies, developed through the research, in other fields?
- What economic impact have the CCFE and Harwell centres made on the UK? (e.g. in terms of value of commercial contracts won to date and potential future wins and leveraged overseas and business investments)

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- What environmental impacts has the nuclear fusion research to date had, in terms of emissions, waste and land use?

In addition to the question areas listed in the ITQ, we may include:

- What international collaborations has UK Government investment enabled, and what benefits have come from these collaborations which would not have been possible without this investment?
- What contribution has UK investment had on encouraging STEM graduates/ international students?
- What industry collaborations have led to spin-offs e.g. start-up technical Support package at Culham's Innovation centre?

An interview guide, in the form of a list of topic-areas to be discussed during these interviews, will be drawn up following the inception workshop with BEIS. This guide will not take the form of a rigid list of questions, but rather pointers for specific areas of discussion to pursue in the interviews. The guide will be shared and agreed with BEIS prior to the interviews.

Strand 2: Desk research and review of data

In parallel to the identification and scoping and mapping of costs and benefits, we will undertake a review of existing literature and datasets. This will include the data and sources already named in the ITQ, which will form the starting point for this strand. We will also screen data on funding as well as background papers, reports and other evidence on the socioeconomic benefits and economic impacts of nuclear fusion research on the UK, where this is expected to add value. We also expect that useful sources of data or literature may be available directly from the Culham and Harwell centres and BEIS. The review will be guided by our own expertise in undertaking literature reviews and desk-based research, and BEIS in order to identify relevant sources of information.

Strand 3: Online survey

Following the scoping and mapping and desk-based research strands, we propose to run an online survey to collect data and evidence from key stakeholders including industry experts, academics, businesses supported by the Culham and Harwell centres, and other key stakeholders.

We understand that there is no publicly available sampling frame or business registers for the survey. As such a key first step will be to compile a sampling frame of key stakeholders for the user survey and the focus groups (Strand 4). This sampling frame will be based on previous similar reviews and information provided by the Culham centre. Other potential sources could include analysis of Gateway to Research projects mentioning the Culham centre or fusion; an analysis of members of industry / fusion associations or groups, or keyword search of other publicly available data such as firm registries, Linked-in, etc. A simple keyword search in Gateway to Research revealed around 210 organisations and a similar number of people working on "Fusion energy" or "Nuclear fusion".

Key areas to explore in the survey will include as a minimum the areas listed in the ITQ; i.e.:

- In which role did you encounter the Culham centre (or other UK fusion centre)?
- How would you rate the UK's standing in fusion research?
- What is your view on Culham's training programmes' contribution to future capability needs in the fusion sector?

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- If your organisation has been supported by the Culham centre for winning contracts from any international projects, how would you rate the support your organisation has received?
- What impacts has your work with the Culham centre (or other fusion centre) – in terms of investment costs, sales, additional jobs created in your organisation or its suppliers, additional profits or scientific progress?
- What synergies do you see between the Culham's activities and those of your organisation? How can joint working in these areas be enhanced?

In addition, we provide here an initial (non-exhaustive) list of potential further areas to explore in the survey:

- New products introduced, or products improved as a result of support by the Culham Centre
- Any licensing agreements, patents, or other IP rights
- Environmental impacts
- Scientific impacts and impacts on scientific progress (e.g. publications, citations, grants)
 - Impact on skills
- Impact on competitiveness of UK industry
- Awareness of / impacts of outreach activities ▪ Collaborations

The online survey will also include questions to substantiate and validate the counterfactual. The detailed list of questions to be asked in the survey will be provided to BEIS in draft form prior to launch and sufficient time will be provided to incorporate any comments or feedback. The survey will also collect information required for the BEIS survey control for estimating online survey respondents burden: Occupation/profession of each respondent and length of time used to complete the survey. These can be incorporated into the questionnaire.

Key risks for the survey as well as the focus groups and depth-interviews include identifying the right persons to engage with and low response rates. To mitigate these risks, we will work closely with BEIS / the Culham centre to identify the correct persons to engage. We also include, in the project team, a dedicated stakeholder consultation manager with long-standing experience. A complete set of risk and our mitigation strategy is provided in PROJ1.4.

Strand 4: Focus groups and depth interviews

In addition to the interviews with Culham and Harwell centre staff and the user survey, we will hold **three focus groups** with key stakeholders. We propose to hold one focus group each for stakeholders from industry, stakeholders from academia, and the advisory groups.

The objective of the focus groups is to obtain further input from stakeholders, complementing the user survey, help unpick additionality (i.e. which benefits would not have occurred in the absence of government investment in nuclear fusion), as well as identify spill over effects of the nuclear fusion programme.

As suggested in the ITQ, the industry focus group will focus on identifying the additional value the CCFE has added to supporting firms in winning contracts and to accelerate commercialisation. The academics and advisory group focus groups will focus on attendees' views on the scientific progress of CCFE fusion technologies as well as CCFE's contribution to research excellence and meeting the needs of future skills in this area.

The focus groups will be completed with around **10 in-depth telephone interviews** with key stakeholders unable to attend the focus groups.

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The basis for potential attendees to be invited to the focus groups and depth-interviews will be the sampling frame developed in Strand 3. In addition, we propose to also include a question in the online survey seeking to obtain respondents views on stakeholders we should speak to in more depth. We propose to hold focus groups with between 5-15 participants. While smaller or larger groups can be facilitated, these numbers provide the best basis for a fruitful discussion in our experience.

We propose to hold the focus groups after the online survey to add additional depth to the data collected via the survey. However, we are flexible should BEIS have a different preference. As such we propose to agree timings with BEIS at the inception meeting. Again, a topic guide of areas to be explored in detail in the focus groups and the complimentary depth interviews will be drafted and shared with BEIS prior to holding the focus groups and interviews.

Strand 5: Case studies of spin-offs / firms supported by the Culham centre

To assess the direct and wider effects of nuclear fusion research undertaken at the Culham centre on spin-offs and other firms supported by Culham centre and to understand the mechanisms that drive these impacts, we will develop three case-studies of spin-offs/firms supported by Culham centre.

The aim of the case studies is to identify more details of spin-offs and the Culham centre's role in developing these technologies and supporting these firms and their suppliers. In particular, the case studies will seek to identify the direct and indirect effects on business growth in terms of: i) the value of investment costs; ii) contracts won so far; iii) employment/sales growth; iv) profit; and, v) scientific progress (e.g. via intellectual property generated).

In addition, we envisage that there may be further areas worth exploring not covered by these categories. As such, we will again deliver a draft stakeholder consultation guide to BEIS which, once agreed, will guide the discussion with firms.

We propose to conduct the case studies via semi-structured interviews. Given the nature of the data sought, we propose to send the developed discussion guide to interviewees prior to the interview so that they can collect and prepare any necessary data.

Strand 6: Impact assessment

The next phase of the study will bring together and synthesise the collected information and data to quantify the costs and benefits of nuclear fusion research in the UK. This will include data collected via a variety of channels including the depth-interviews with Culham/Harwell staff (Strand 1), existing data and reports identified in the secondary data review (Strand 2), online survey (Strand 3), focus groups and interviews (Strand 4); and interviews with spin-offs / firms supported by the Culham centre (Strand 5).

Wherever possible, we will seek to quantify benefits following HM Treasury Green Book guidance. Useful approaches typically fall into the categories below:

Market-based estimates: The usual assumption for transactions made in private markets is that the price paid reflects the producer's profit-maximising position (given constraints of competition etc) and at most the consumer's willingness to pay for the good or service due to the utility they receive from it. While we understand that the Culham centre and fusion researchers are not profit-maximising in nature, market based estimates can be used to assess benefits where fusion research feeds into the development of products or services.

Perception of value estimates: People derive utility from services that are not provided via a private market, so market prices cannot be used to value these services. In these cases, an alternative non-market valuation method for valuing the service is required, for example a stated preference willingness to pay survey. Willingness to pay for a service captures consumer surplus, since it includes the full value of the consumer's utility.

Avoided cost estimates: When comparing two scenarios in which a certain service is/is not provided the cost avoided by providing the service compared to not providing the service is also frequently used.

We envisage to use a mix of these and, where applicable, other approaches to value benefits, depending on the benefit streams identified. To produce an aggregate estimate of the overall net economic benefit, the study will bring together multiple benefit streams. The analysis will be undertaken in real prices and following government guidance and best practice on evaluations (Green Book/Magenta Book).

The analysis will be undertaken by building a model in Excel, which will compute the key results of the study including total present benefits, total present costs, net present value, and benefit-cost ratio, relative to the baseline scenario. The quality assured excel model will form an output for the study that will be shared with BEIS.

The impact of assumptions on the results will also be assessed via sensitivity analysis (see below). In case different sources indicate that different parameter values should be used, we will use the value that is the most relevant to the study, most up to date, and most robust value (in terms of the method used to determine the value).

Finally, where there is insufficient data to quantify benefits, we will highlight the benefits in a qualitative way. This mixture of quantitative and qualitative analysis will allow us to assess a wider range of socio-economic impacts of UK nuclear fusion research.

Analysis of scientific impacts and progress

In addition to the economic analysis the evaluation will also collect evidence on scientific impacts and progress. This information will be combined with bibliometric data to assess:

- the number of publications;
- citations (e.g. number of citations compared to other research, number of publications in top citation percentiles, average citations per paper); and,
- impact measures (e.g. field weighted citation impact, H-index).

Potential data sources include Culham's Annual reports, which contain lists of their publications, as well as Google Scholar and Microsoft Academic Search, which can be analysed using the Publish or Perish software¹. We are also happy to provide further bibliometric analysis using Elsevier SCOPUS or Web of Science. However, as we would have to purchase a license for these databases, this would be at an additional cost.

In addition, information on specific tangible impacts will be collected via the online survey, stakeholder consultations and desk research. For example, in a current study we are undertaking for EPSRC, we have estimated part of the scientific benefits of High Performance Computing in terms of reduced/avoided physical experiment costs.

Contribution analysis

To assess the contributions of nuclear fusion research to the identified impacts, a contribution model will be developed and populated throughout the analysis. We will use the Theory of Change (ToC) approach. **A ToC is a map of the investment/program pathway to change**, reflecting the long-term vision (scientific excellence, UK competitiveness, etc.), direct outcomes (e.g. industry spin-offs, international collaborations), and the

¹ <https://harzing.com/resources/publish-or-perish>

preconditions/intermediate outcomes and activities that are required to achieve the outcomes. The ToC opens the way to using a generative causal logic in the evaluation activity: looking not only at whether action X is consistently associated with outcome Y, but also why this might be the case, and whether there are variations in outcome under different circumstances.

Early on in the study a logic model setting out the current policies, expected outcomes and ways of contribution will be developed. The model will initially be populated based on the existing data collected in Strands 1 and 2. This will highlight potential weaknesses and gaps, which need to be addressed and via the online survey, focus groups and case studies. Based on additional evidence collected via Strands 3-5, the model will be revisited and updated in light of the new evidence.

Dissemination:

London Economics would be pleased to support BEIS in **dissemination** of the study by presenting the study findings to a wider policy audience/senior policy-makers through-out government and the private sector. We would also provide press releases and disseminate the report through our website and social media channels (Twitter, LinkedIn). Additional ways in which we can support dissemination will be discussed at the inception meeting.

PROJ1.2: Staff to deliver

This section provides an overview of roles and responsibilities as well as short bios for all London Economics staff that will deliver the contract. In addition to the LE core team, we subcontract [REDACTED] to facilitate the focus groups. At the end of each bio, dedicated backup staff are named for each key service component. This will allow us to maintain our ability to deliver high quality service through the lifetime of the project.

[REDACTED] **Project Director.** [REDACTED] leads our primary research pan-European projects for the European Commission and European Parliament, and bespoke impact assessment work for clients such as the UK Met Office, the Australian Bureau of Meteorology, Innovate UK, BEIS and

EPSRC. Recent projects include an economic impact assessment for the UK Government's General Review of the Met Office; Impact assessment of the Australian Bureau of Metrology for the Australian Government funding review of meteorological services; Assessment of Industry 4.0 in Space Manufacturing for Innovate UK; Assessment of the investment landscape for Advanced Materials for Innovate UK. Charlotte is currently directing a study evaluating the impact of EPSRC's investments in HPC. **Substitutes:** [REDACTED]

[REDACTED] **(Economic Consultant), Project Manager.** [REDACTED] has extensive experience in evaluations of advanced technologies. He is currently project managing our study, for the EPSRC, evaluating the impact of EPSRC's investments in High Performance Computing. Further recent examples of his work include an assessment of the economic impact of the loss of GNSS to the UK for Innovate UK, UKSA and the Royal Institute of Navigation; an assessment of the impact of Industry 4.0 technologies on the UK Space Manufacturing sector for Innovate UK; and a study assessing the financing landscape for Advanced Materials in the UK, for Innovate UK. He has also undertaken impact assessments of higher education institutions for the University of Birmingham, Cardiff, and York. [REDACTED] holds a B.A. in Philosophy, Politics and Economics from the University of York (first class honours) and an M.Phil. in Economics from the University of Cambridge. [REDACTED] also has a substantial technical knowledge, having graduated with a distinction in Informatics and Software Engineering from the Secondary Technical College Leonding, and over two years' experience working

as a professional software developer prior to joining London Economics. [REDACTED]

[REDACTED] (Divisional Director) has 13 years of experience with the firm and will be **Quality Assurance Manager and Expert Adviser**. [REDACTED] has considerable expertise in evaluations and impact assessments for example through his recent work on the evaluations of the HPC applications of the Australian Bureau of Meteorology, and the UK Ordnance Survey. Over the last

six years [REDACTED] managed annually recurring studies for McDonald's and Hyundai to quantify their contribution to the European economy, using detailed activity-level revenues and costs, as well as an analysis of upstream and downstream value added and multiplier effects, looking at service delivery models and value added across the entire range of UKTI's activities. [REDACTED] has years of experience designing complex bespoke methodologies using cutting-edge analytical tools and has conducted data-intensive analysis for clients that include some of Europe's largest companies as well as governments in the UK, Europe and the Middle East. He has substantial knowledge of economic evaluation and appraisal methodologies, cost-benefit analysis and stakeholder consultations. [REDACTED] has Master's degrees in Economics (University College London) and European Competition Law (King's College London).

Substitutes: [REDACTED]

[REDACTED] (Senior Economic Consultant) will be senior team member. [REDACTED] has 4 years of consulting experience at London Economics including excel modelling, systematic data gathering and validation, econometric analysis, primary and secondary research, and report writing. [REDACTED] has considerable experience at conducting in-depth cost-benefit analyses and impact assessments consistent with the HM Treasury's Green Book guidance, having assessed the impact of government agencies, universities, private sector companies, and entire industries. [REDACTED] is further experienced in assessing the impact of key infrastructure having produced a cost-benefit model to value the Australian Bureau of Meteorology's meteorological data and services. [REDACTED] also played a key role in providing quantitative evidence on both the overall value of the UK Met Office's meteorological and climate services and the share of that value that is attributable to the Met office's supercomputer. [REDACTED] further assessed the impacts of geospatial data for the Ordnance Survey, Britain's national mapping agency. More recently [REDACTED] contributed to a study quantifying the impact of satellite derived earth observation data to the UK government. [REDACTED] holds an MSc in Economics from the London School of Economics and Bachelor's degrees in both Economics and International Relations from the University of St. Gallen. **Substitutes:**

[REDACTED] are junior members at London Economics and will play a key part in **supporting the team** with day to day research activities such as desk-based research, literature reviews, stakeholder consultations, analysis of evidence, and reporting.

Substitutes: [REDACTED]

[REDACTED] is a London Economics Associate and will be **Stakeholder Engagement Manager**. [REDACTED] has seventeen years of experience as a Freelance Researcher, Interviewer, and Stakeholder Consultation Project Manager. [REDACTED] is highly experienced in every aspect of stakeholder consultations, from researching and identifying stakeholder contacts to creating and running online surveys as well as conducting individual/group interviews by phone and face-to-face. **Substitutes:** [REDACTED]

[REDACTED] will be **Focus Group Facilitator**. [REDACTED] is a co-founder of Wilson Sherriff, which offers consultancy and facilitation services to organisations in the public, private and voluntary sectors both nationally and internationally. He is a Certified Professional Facilitator and former Vice Chair of the global board, International Association of

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Facilitators. He also provides facilitation training and is an international assessor of facilitation competence for the International Association of Facilitators. [REDACTED] has extensive experience of leading and taking part in research, evaluation and consultancy projects in particular on public policy issues - facilitating high level meetings, major projects, consultations and conferences. **Substitutes:**
[REDACTED]

Required support from BEIS

We do not envisage to need any outside support for delivery of the contract, beyond the above team members. To ensure the project runs smoothly we would expect the following support from BEIS:

- A named project manager from BEIS who will have direct contact with LE's Project Manager [REDACTED] and Project Director ([REDACTED])
- Signed letter of introduction from BEIS confirming LE has been engaged to undertake the study. This will be used to support engagement by organisations for the stakeholder consultation phase of the project.
- Contact details of key CCFE staff and (where available) for stakeholders that should be included for interviews, user survey and focus groups
- Sign-off of the interview and focus group guides, and online survey before launch of consultations.

PROJ1.3: Understanding nuclear fusion research

Fusion energy offers the promise of a safe, green, and abundant power source. Unlike nuclear *fission*, used in existing nuclear power plants, fusion does not create a chain reaction that is at the heart of safety concerns associated with nuclear power. Moreover, nuclear fusion generates far more energy than fission, relies on a nearly unlimited fuel supply, and does not produce radioactive waste or harmful emissions.²

Despite significant advances since the early attempts in 1960s, substantial challenges remain in harnessing fusion as an energy source. In experimental machines known as tokamaks, gaseous hydrogen fuel becomes a plasma under the influence of extreme heat and pressure. If the plasma is sufficiently dense and confined for long enough using magnetic fields, nuclear fusion can occur. In all experiments to date, however, the amount of energy required to set off and sustain the reaction was larger than the amount of energy generated.³ The world's largest tokamak ITER, currently being built in Southern France by 35 cooperating nations including the UK, is set to be the first fusion experiment to produce a net energy gain. The breakthrough, expected in 2035, should pave the way for the first demonstration fusion power plant DEMO to produce electric power in 2050.⁴

Fusion energy requires technological capabilities, material properties, and diagnostic precision far beyond the existing industry standards. Towards the long-term goal to fusion energy, the research has already produced advances in other disciplines including astrophysics, material sciences, superconducting technologies, high-precision engineering, robotics, computing, diagnostics, and modelling.⁵ This scientific progress has found applications in a variety of areas including medicine, energy, transport, electronics, national defence, telecommunications, or the environment.⁶ For example, superconducting magnets

² EUROfusion (2018), "European Research Roadmap IN BRIEF to the Realisation of Fusion Energy."

³ ITER, "What is ITER?" <https://www.iter.org/proj/inafewlines>

⁴ ITER, "What is ITER?" <https://www.iter.org/proj/inafewlines>; European Commission (2017), "Interim Evaluation of indirect actions of the Euratom Research and Training Programme 2014-2018."

⁵ EUROfusion (2017a), "Fusion Research Spinning off short-term benefits"; EUROfusion (2017b), "Fusion spin-offs" <https://www.euro-fusion.org/spin-offs/>; Fusion Communications Group (undated), "Fusion Spinoffs making a difference today"

⁶ Ibid.

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developed to control fusion reactions are used in MRI scans.⁷ Palladium alloy membranes, designed for cleaning up fusion waste, effectively treat waste from chemical and automobile industries.⁸ A nuclear detection system built for a tokamak in the US is used to identify nuclear materials as an anti-terrorism device.⁹

The UK has been at the centre of nuclear fusion research since its foundations in 1950s.¹⁰ The Culham Centre for Fusion Energy (CCFE) is not only the main site for fusion research and development in the UK, but also a leading European research hub. The centre houses currently the world's most powerful tokamak JET and pioneered and led the development of spherical tokamaks, which are seen as ideal designs for the future DEMO power plant.¹¹ The upgraded spherical tokamak MAST-U, set to start its operations later this year, represents a technological state-of-the-art in fusion energy research. CCFE has also played a crucial role in the development of the new European research centre and tokamak ITER in France.

While most of the research funding has come from the EU, the UK government spent a significant amount of money on fusion research over several decades.¹² The main aim of this project is to understand the costs and benefits of this funding, including the impact of fusion research outside of fusion energy. A comprehensive analysis of the costs and benefits to date would play an important role in informing future spending decisions. Considering that European fusion research is heavily integrated both in funding and operational aspects, the analysis needs to consider the broader European perspective alongside the UK dimension.

The analysis of financial costs of fusion research should consider both public and private costs. Unsurprisingly, given the long-term nature, high costs, and uncertain result of fusion research, the activities have been primarily driven by public funding with only a limited role for private investment. This has changed somewhat in recent years – for example, the private UK venture Tokamak Energy that aims to commercialise fusion energy by 2030 has already raised over £50 million of private investment.¹³

The financial costs of the UK's fusion research include not only the research grants and experimental costs, but also the financial costs of the investment in facilities and equipment, administration and staff costs, investment in skills, and industry collaborations. An important part of fusion research is led by UK universities, research centres and their industry networks through partnerships with the CCFE.¹³

An analysis of the impact of fusion research should map the direct and indirect scientific, economic, and environmental impact. Most of the scientific advancement resulting from basic fusion research is not patented, open-source and freely available for industrial adoption. The analysis should consider both the outcomes of the research – publications, citations, experimental results – as well as its broader economic impact on innovation and already commercialised (patented) spin-off industrial applications. Where possible, the impact on skills and jobs should also be considered.

⁷ EUROfusion (2017a)

⁸ EUROfusion (2017a)

⁹ Fusion Communications Group (undated)

¹⁰ Tender documents

¹¹ CCFE, "MAST Upgrade" http://www.ccf.ac.uk/mast_upgrade_project.aspx

¹² BEIS (2015), "Triennial review of the UK atomic energy authority"; Tender documents.

¹³ Tokamak Energy (2018), "Total funds raised for fusion venture Tokamak Energy exceeds £50M,"

<https://www.tokamakenergy.co.uk/total-funds-raised-for-fusion-venture-tokamak-energy-exceeds-50m/>; CNBC (2019), "Why Bezos and Microsoft are betting on this \$10 trillion energy fix for the planet,"

<https://www.cnn.com/2019/03/06/bezosmicrosoft-bet-on-a-10-trillion-energy-fix-for-the-planet.html>; MIT News (2018), "MIT and newly formed company launch novel approach to fusion power," <http://news.mit.edu/2018/mit-newly-formed-company-launch-novel-approach-fusion-power-0309>. ¹³ See Fusion CDT website, <https://www.fusion-cdt.ac.uk/>.

Project delivery

Our consultants are highly-qualified economists with extensive experience in applying a wide variety of best practice analytical techniques to advanced technology sectors. For this study we provide an experienced team with expertise in computing, stakeholder consultation, impact assessments in line with government guidance (HMRC Green Book / Magenta Book), including impact assessments of research institutions, and complex project management with multi-mode evidence collection (see PROJ1.2). In all the research work we undertake, we invest appropriate resources to ensure that the project runs smoothly from inception to the presentation of final deliverables. The Project Director, [REDACTED] will ensure that the resources of London Economics are properly allocated throughout the research project to guarantee the ongoing quality and delivery of all outputs. Examples of our recent relevant experience are listed below.

- Impact of EPSRC's investments in High Performance Computing (EPSRC, ongoing)
- Impact of Industry 4.0 for Space Manufacturing (Innovate UK, 2018)
- Socio-economic impact of ECMWF's High Performance Computing (Met Office, 2017)
- A study of the economic impact of the services provided by the Bureau of Meteorology (BoM), Australia (Australian Department of the Environment, 2017)
- Socio-economic impact of Ordnance Survey (Ordnance Survey (OS) and UK Government Investments (UKGI), 2016)
- Met Office General Review – Economic Analysis (Met Office, 2015)
- Socio-economic impact assessment of higher education institutions (various, incl. Warwick, York, Leicester, Cardiff)

PROJ1.4: Project Plan and Timescales

In the figure below we present our detailed timeline for carrying out the study based on our proposed methodology. We include milestones for important sign-off dates for data collection materials by BEIS and key project milestones for an Interim Report, the Draft Final and Final reports.

Ongoing project management meetings are proposed for every week at which we will provide a progress update for the overall project. Project management meetings will also be used to discuss any issues or concerns should these arise.

We include in our project team experienced consultants with extensive project management and delivery experience, who will ensure the necessary resources are available to minimise risks of time slippage. We also remain flexible to priorities key tasks such as information collection and analysis throughout the project as required. Further details on key risks and our mitigation measures are presented in the next section.

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<p>Scoping and mapping of costs and benefits of nuclear fusion research: Failure to correctly attribute benefits.</p>	<p>Our team is experienced in undertaking desk-based reviews internationally and has undertaken similar reviews mapping investments to benefits (including research, commercial and social benefits). We will apply our robust desk based review process and work closely with BEIS to identify relevant data sets and reports (academic, policy and grey literature). We will build a database of reports/data sets with a ranking for relevance. This database will be shared with BEIS. We have also included a dedicated workshop facilitator with long-standing experience to support us during the focus groups.</p>
<p>Identifying key stakeholders and effectively engaging stakeholders in the study: Failure to identify the correct person to interview within an organisation. Low response rates to stakeholder questionnaire.</p>	<p>We include on our team our dedicated stakeholder manager [REDACTED] [REDACTED] specialises in the identification of individuals within organisations to participate in bespoke interviews and surveys having delivered to e.g. UKRI, Innovate UK, UK Space Agency. [REDACTED] manages the interview diary to ensure the impact on interviewees is minimised, and manages the reminders to maximise completion rates for the survey.</p>
<p>Valuing impact of research</p>	<p>Quantifying the impact of research is inherently difficult. In addition, there may also be a knowledge gap, where researchers are not necessarily aware of the downstream impacts of their research. Our team is experienced in quantifying impacts of academic research as part of assessments for universities (e.g. York, Birmingham, Cardiff). We are also currently undertaking a similar project quantifying the impact of HPC research undertaking on EPSRC funded HPCs. In addition, London Economics has a dedicated education practice with years of experience in quantifying the impact of higher education institutions, including the impact of universities' research activities; on which the project team can draw as needed.</p>
<p>Absence of data for estimation of benefits: Some benefits may not have sufficient data for quantitative estimation</p>	<p>In our previous work for the UK Met office impact assessment of HPC capacity we adopted a qualitative assessment approach for unquantifiable benefits. This will be applied in this study for BEIS. We have also used this approach in previous research for BEIS where we evaluated the economic benefits of space exploration to the UK economy. This research was part of the evidence based used to support funding for the establishment of the UK Space Agency.</p>
<p>Inaccurate modelling of benefits and costs:</p>	<p>We will construct a transparent model based on the benefit mapping (see PROJ 1.1) which maps out the flow of benefits from nuclear fusion investments to benefits. We will apply sensitivity</p>

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<p>Inaccurate and non-replicable outcomes</p>	<p>analysis around the key assumptions to transparently illustrate how the estimated impacts may change as variable assumption change. The sensitivity analysis parameters will be based on the desk research and stakeholder interviews and expert knowledge held within BEIS / the Culham centre.</p>
<p>Insufficient staffing and resourcing</p>	<p>We allocate a highly experienced team in impact assessments in advanced technology as well as impact assessments, economic modelling and stakeholder consultations. Our dedicated Project Director [REDACTED] has extensive experience managing complex multi-modal data collection projects for UK Government, Regulators and the European Commission. [REDACTED] directed the Impact Assessment of the UK Met Office HPC for the Met Office General Review, and the Australia Bureau of Meteorology HPC impact assessment. Our dedicated Project Manager [REDACTED] is experienced in complex impact analysis. [REDACTED] currently also leads on our impact assessment of EPSRC's investments in HPC and has recently completed an economic assessment of Industry 4.0 technologies in space manufacturing for Innovate UK. [REDACTED] is also experienced in impact assessment methods and worked on the Australian Bureau of Meteorology Impact Assessment. They will be supported by junior members [REDACTED] and [REDACTED] ([REDACTED] and our dedicated consultation manager [REDACTED]. We also included designated backup staff for each team member, who can step-in in the unlikely event that a member of the core team becomes unavailable.</p>
<p>Insufficient sector knowledge and experience</p>	<p>Experience in impact assessment of advanced technologies including assessments of High Performance Computing facilities for the UK Met Office and Australian Bureau of Meteorology and the EPSRC and extensive experience in advanced technology sectors (aerospace). Expertise in evaluation of academic research impacts for various universities. Track record in Market sizing, analysis and demand forecasting; Business case support (economic and financial feasibility); Valuefor-Money (Cost-Benefit Analysis, Cost Effectiveness Analysis); Impact assessment and policy evaluation (especially public utility and spillover benefits); Sophisticated statistical analysis (econometrics, regression); Analysis of industry structure and competitive dynamics; Commercial due diligence.</p>
<p>Failure to Deliver research on time and on budget</p>	<p>Dedicated Project Director [REDACTED] who has considerable experience of directing and delivering large scale complex research projects across the public sector in a range of countries internationally. We have included a detailed project timeline which accurately reflects the project approach proposed as well as the tasks and resources required for the timely delivery of this project. We have provided a fixed cost quote for undertaking this research work. There is no possibility of reverting to BEIS for additional resources to complete the project. We welcome the BEIS' input into the strategic delivery of the project but we ensure that BEIS will assume no risk or responsibility for the day-to-day delivery of</p>

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	the project.
Inexperience in contribution	Our team includes experts who have delivered a range of Contribution, Formative and Theory of Change Analyses, [REDACTED]
analysis and theory of change	[REDACTED] For example, the Open Data Institute “Study of the economic and social returns from the ODI’s innovation programme” (2019). European Commission Executive Agency for Small and Medium-sized Enterprises (EASME) “Accompanying study to the pilot action ‘European SME Innovation Associate – Pilot’”, (2019). This wide-ranging study provides a formative evaluation of one of the European Commission’s key support programmes for innovation in the small business sector. Department for Education “Parenting Early Intervention Programme Evaluation”. London Economics, in association with the University of Warwick, were commissioned to undertake a process evaluation of targeted early intervention parenting classes in England. As part of the formative evaluation and to ensure that the lessons of the evaluation could be fed into developing services, the analysis also involved a host of consultations with stakeholders.

Annex B- specification

1. Background

Background on nuclear fusion energy research in the UK

Nuclear fusion is a high potential future energy source that aims to replicate the nuclear reaction that takes place in the Sun. Fusion could play an important role in the future energy landscape as a sustainable energy source, since it does not produce greenhouse gases and the fuel used is widely available, crucial to one of Grand Challenges underpinning the Industrial Strategy – Clean Growth.

The UK has been a key player in establishing the foundations to fusion energy since 1950s. The Culham Centre for Fusion Energy (CCFE) is the central site for fusion research and development in the UK.

UK Atomic Energy Agency (UKAEA) officially opened CCFE in 1965, having moved its fusion research operations from the nearby Harwell research site, which is now being decommissioned. Culham also amalgamated fusion activities that were previously undertaken at Aldermaston and other UK locations to form a national centre for fusion research.

In 1977, following protracted negotiations, Culham was chosen as the site for the Joint European Torus (JET) tokamak. Construction began in 1978 and was completed on time and on budget, with first plasma in June 1983. Since then the machine has gone on to set a series of fusion milestones, including the first demonstration of controlled deuterium-tritium fusion power (1991) and the record fusion power output of 16 megawatts (1997). JET is the world's largest and most powerful tokamak and crucial to development of the International Thermonuclear Experimental Reactor (ITER), the focal point of the European fusion research programme, currently under construction in the South of France.

In the 1980s, Culham Laboratory was instrumental in the development of the spherical tokamak concept – a more compact version of the tokamak. This is thought to offer potential advantages by enabling smaller, more efficient fusion devices. The START (Small Tight Aspect Ratio Tokamak) experiment at Culham (1991-1998) was the first full-sized spherical tokamak. Its excellent performance led to the construction of a larger device, MAST (Mega Amp Spherical Tokamak), which operated between 2000 and 2013. MAST has recently been subject to an upgrade (in practice a complete rebuild) to extend its capabilities and is currently being commissioned. The upgraded machine, MAST-U, is a UK facility but it will be also used by teams of scientists from the EU and there is also a strong collaboration with the USA.

In the 1980s, the UK's involvement in the technology development activities needed for a fusion reactor were ramped down as a result of funding cuts. Consequently, until recently the technology activities have been restricted to those needed for the JET and the MAST programmes. This narrowed the scope and restricted the scale of CCFE technology activities. More recently the EUROfusion programme has significantly increased the scale of technology R&D activities and the UK has seized this opportunity to rapidly expand its technology activities. This UK is already a major player in some aspects of the European fusion technology activities. In other areas CCFE is still at relatively early stages of rebuilding its capabilities but is making rapid progress following significant recent UK investment. Given this context there are not many examples of spin-offs in the UK and so a wider European perspective may be necessary to help to form a representative picture of the economic benefits of the fusion programme.

The Centre's current activities encompass tokamak plasma physics, technology developments for the DEMO prototype fusion power plant, the development of materials suitable for a fusion environment, engineering activities, the training of students, graduates and apprentices, and public and industry outreach activities.

This project aims to gather evidence to evaluate the impacts, i.e. costs and benefits, of

nuclear fusion research in the UK to date, this evaluation will also consider the counterfactuals and the subsequent impact on the UK to date. Possible counterfactuals will include scenarios where the Government would directly invest in technologies such as Robotics, which often benefit from Fusion spin-off research.

The UK has been leading on fusion research over several decades; a significant amount of money has been spent by the UK government and other organisations, and it is important to understand the costs and benefits that funding has had, including unintended costs and benefits such as spin-off research, to inform further fusion research spending decisions.

Related reviews and sources

Current published reviews on nuclear fusion research in the UK provided a body of positive evidence for the UK's leading expertise in this field with a focus on scientific impacts. However, there is limited evidence on the economic impacts of fusion research on the UK with a lack of quantitative assessments.

- EPSRC Independent Review of Fission and Fusion Research, March 2016

This review concluded that the UK's fusion research programmes are of world-class quality, in facilities, people and research impact. For example, Fusion research at CCFE helped the UK industry to win £100m EU fusion research contracts (up to 2015). These programmes were found to be world-leading and cost-effective, while being intimately woven into the international effort.

- Government Office for Science Reports: Nuclear Technologies Trajectory Review (2016)

This Review provides an independent assessment of the UK's priorities, and potential for international collaboration, in the development and demonstration of nuclear energy technologies, including both fission and fusion technologies. On fusion, the Review commends the moves in recent years to start Culham on a journey from being a fusion laboratory to being a civil nuclear laboratory.

- 2015 Triennial Review of UKAEA

In 2015, the then Department for Business, Innovation and Skills conducted a Triennial Review of the UK Atomic Energy Authority (UKAEA), which is responsible for UK and European fusion power research programs at Culham and Harwell. Apart from reviewing the budget, structure and governance of the Authority, this report also commented that CCFE's commitment to training and developing young scientists and engineers, and its contribution to the Culham/Oxford/Harwell triangle for innovation, are key to ensuring that the UK benefits from its investment in fusion technology.

In addition to the above reviews, the EU Commission published several documents related to fusion research, providing background information for fusion research in the EU and in the world:

- European Research Roadmap to the Realisation IN BRIEF of Fusion Energy

The European Fusion Roadmap outlines the research and development required to provide the basis for an electricity-generating fusion power plant in the next 50 years, but with no specific timetable outlined. In the short to medium term, the key research infrastructure is the ITER project - a worldwide endeavour for constructing a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy. This is planned to lead to DEMO - nuclear fusion power station that

demonstrates first electricity production grid to the grid by fusion.

- The interim evaluation of the 2014-2018 Euratom programme

This European Commission's evaluation concluded that Europe currently has a leadership position in fusion research and this has been achieved through the Euratom programmes that have led to a coherent approach in the Member States. The fusion part of the Euratom Programme is clearly relevant as it enables Europe to address the challenge of ensuring an energy production that simultaneously meets the goal of long term sustainability, security of supply and support to the development of the economy. The evaluation recommended the JET experimental research should be extended up to 2024, and highlighted JET is a unique European fusion asset and it is a fundamental part of the ITER project. JET was found to be a clear example of European Added Value.

- [Spin-offs from fusion research](#)

This EUROfusion website describes how, while the fusion community continues its quest to harness fusion for energy needs, the research has borne some short-term benefits. Fusion research with its complex, multidisciplinary nature has pushed advances in disciplines ranging from medical technology and environment, to astrophysics and material sciences. But there are no quantitative data on numbers and value of spin-off companies and their associated impacts.

2. Aims and Objectives of the Project

Project aims and objectives:

- to generate evidence to inform future UK government policy relating to nuclear fusion research;
- to assess how fusion research and its associated infrastructure has affected the UK with a focus on scientific progress, scientific impact, industry links, environmental impact and economic impact;
- to provide a suite of case studies that include both direct impacts from UK fusion research and indirect/spill-over impacts (in plain language); and
- to identify the financial costs of the UK nuclear fusion research and associated infrastructure.

This project aims to provide an independent impact evaluation of the nuclear fusion research programme to build a solid evidence base for long-term future strategic and investment decisions in wide-ranging policy contexts including spending reviews and EU-exit.

Overarching research questions to be answered:

- What have been the public and private financial costs of the UK's nuclear fusion research?
- What impacts has UK nuclear fusion research had on the UK?
 - Scientific impact and progress
 - Environmental impact
 - Economic impact

1. Suggested Methodology

We would welcome bidders' alternative and innovative suggestions for methodology providing that they also meet the project aims and objectives. Below we set out in some further detail important aspects of the key research questions in terms of where we are seeking evidence and possible metrics.

- What have been the public and private financial costs of the UK's nuclear fusion research?
 - Investments in facilities and equipment
 - Administration costs
 - Skills and talent investment
 - Research programme experimental costs
 - Collaborations including business support
 - Staff costs

- What impacts has UK nuclear fusion research had on the UK?
 - Scientific impact and progress
 - Publications, citations & impacts
 - Major scientific/technological progress and outcomes
 - Any increased and accelerated translation of research into innovation/commercialisation of technology in the fusion industry or any other field
 - Environmental impact
 - Land use change
 - Positive or negative impacts on emissions
 - Waste issues
 - Economic impact
 - Leveraged overseas and business investments
 - Industry links and business benefits including:
 - Number of spin-offs, new firms and supply chain firms supported
 - Direct and indirect business growth such as increased profits, employment and sales or value added
 - Value of IP income or from licenses
 - General capabilities and wider benefits arising from fusion research and related quality assurance technologies
 - Value of commercial contracts won to date and potential future wins and the number of high skilled jobs created/safeguarded
 - Occupation (SOC) and wage levels of those jobs
 - Industry (SIC) of those jobs
 - Apprenticeships and training programmes
 - How these programmes contribute to future capability needs in the sector

Based on our experience, we recommend the project use Contribution Analysis, based on a mixed methods approach, to determine the contribution of nuclear fusion research in the UK to the observed effects and a causal link between the activities and the effects.

It will be necessary to describe an appropriate counterfactual in detail, consisting of what would have happened in the absence of nuclear fusion research. This will need to

consider what the research money might have instead been spent on; how the land for the Culham and Harwell centres might otherwise have been used; and what the fusion industry in the UK might have been like in the absence of UK Government funding.

We recommend the project will include the following elements:

1. **Around 5 in-depth interviews** with key staff from the Culham and Harwell centres to acquire key data on spend, scientific impacts and leveraged investment and to identify key stakeholders and beneficiaries. Prior to these interviews, the centres will be provided with a list of requested information in order for them to prepare data. Where appropriate, the answers should be accompanied by relevant documents. These interviews will be used to clarify information and acquire further data if needed.

Key research questions at this stage could include:

- What has been spent from public, private and overseas sources to date on nuclear fusion research and development in the UK?
 - What has nuclear fusion research contributed to the UK Nuclear fusion research? (e.g. in terms of publications, numbers of PhDs/apprentices trained, and major scientific progress made)
 - What evidence do you hold in relation to the scientific impact of nuclear fusion research in the UK, in terms of both progression towards the eventual commercialisation of nuclear fusion as an energy source, and the use of technologies, developed through the research, in other fields?
 - What economic impact have the CCFE and Harwell centres made on the UK? (e.g. in terms of value of commercial contracts won to date and potential future wins and leveraged overseas and business investments)
 - What environmental impacts has the nuclear fusion research to date had, in terms of emissions, waste and land use?
2. **A web-based survey** to invite submissions of evidence and findings from this survey will inform discussions in meetings with key stakeholders and case studies. A previous similar EPSRC survey (2016) received 41 responses.

Research questions may include:

- In which role did you encounter the CCFE (or other UK fusion centre)? (multiple options)
- How would you rate the UK's standing in fusion research? (multiple options)
- What is your view on CCFE's training programmes' contribution to future capability needs in the fusion sector? (multiple options and comments box)
- If your organisation has been supported by the CCFE for winning contracts from any international projects, how would you rate the support your organisation has received? (multiple choices)
- What impacts has your work with the CCFE (or other fusion centre) – in terms of investment costs, sales, additional jobs created in your organisation or its suppliers, additional profits or scientific progress?
- What synergies do you see between the Culham' activities and those of your organisation?
 - How can joint working in these areas be enhanced?

As this is a commissioned evaluation in a specialised area, there is no publicly available sampling frame/business registers for the survey and focus groups.

We expect contractors to compile a sampling frame of key stakeholders including industrial specialists, leading academics in fusion research and businesses supported by CCFE based on previous similar reviews and mainly from information provided by the CCFE. Further, the contractors could do analysis of Gateway to Research to identify projects which mention Culham or Fusion. This could give them a sample frame for academics involved in the field and some information on outcomes (if not impacts).

3. **Around three focus groups** with representatives of key stakeholders from the industry, academia and advisory groups to unpick additionality and spill over effects of the programme. This may be complemented by around 10 in-depth telephone interviews for those who are not able to attend these group meetings. These methods will be used to refine online questions to be more in-depth and enrich the survey data.

Questions to be asked in these groups will vary by type of attendee organisations. For the industry focus group, we'll identify additional value the CCFE has added in supporting these firms to win contracts and to accelerate commercialisations. The academic and advisory groups' questions will probe attendees' views on the scientific progress of CCFE fusion technologies and its contribution to research excellence and meeting the needs of future skills in this area.

4. **Around three case studies** can be conducted through semi-structured interviews with spin-offs and firms supported by CCFE:
 - o to assess direct and wider effects of Culham nuclear fusion research on these organisations
 - o to understand mechanisms that drive impacts.

These case studies will identify more details of spin-offs and CCFE's role in developing these technologies and supporting these firms and their suppliers. Research questions will focus on CCFE's direct/indirect effects on business growth in terms of the value of investment costs, contracts won so far, employment/sales growth, profits, and scientific progress perhaps measured partly through intellectual property generated.

5. **Desk research and review of data** on funding, background papers and reports

The analysis should feed into an overall impact assessment carried out using HM Treasury Green Book techniques. This assessment will be quantitative, taking into account displacement and crowding out, unless there is insufficient data to monetise the benefits, in which case it will be qualitative.

2. Deliverables

Project inception meeting: contractors and BEIS steering group will meet to discuss how the project will proceed.

Online survey and Questionnaire: a questionnaire designed for an on-line survey on an appropriate platform (such as Citizen space). Appropriate measures (such as sending reminders) will be taken to achieve a good response rate.

Information required for the BEIS survey control for estimating online survey respondents burden: Occupation/profession of each respondent and length of time used to complete the survey. These can be incorporated into the questionnaire.

Dataset of survey results: key findings and processed/raw survey data

Regular updates on emerging findings and project progress: weekly catch-up with the project manager/steering group to track progress and address any issues that may arise, and priorities work as advised by the steering group.

Undertaking research and analysis with presentations: the contractors will implement the agreed analytical/research approaches including focus groups/telephone interviews/case studies, where needed, to respond to each research question. The contractors are also expected to present their work to the steering group to manage expectations and emerging issues.

Interim report of findings: the contractor will produce a draft report at the end of analysis stage. The contractor will agree the report structure with the project manager, but overall, the report should include an executive summary, context to the work, methodology, data, results, and conclusions. The report will follow the gov.uk guidelines on style, accessibility and should meet plain English requirements. With the draft report the contractors should also provide:

- fully documented software code, used for analysis, and all underlying data (with complete reference) and datasets underpinning the analysis (where the data is not publicly available, we expect contractors to organise access to the project folder in secure data service (SDS);
- all tables and figures in the report need to be in an excel spreadsheet with data included; and
- all models will be compliant with BEIS QA practice. Further information on BEIS QA practice can be found here: <https://www.gov.uk/government/collections/quality-assurance-tools-and-guidance-in-decc>.

Quality assured final report for publication

The final report for this research project must be formatted according to BEIS publication guidelines, template and adhering to BEIS accessibility requirements on gov.uk. The BEIS project manager will provide the template. The contractor needs to ensure the drafts are free from typos, grammatical or syntax errors and are accessible to technical and non-technical audience.

Please ensure you note the following in terms of accessibility:

Checklist for Word accessibility

Word documents supplied to BEIS will be assessed for accessibility upon receipt. Documents which do not meet one or more of the following checkpoints will be returned to you for re-working at your own cost.

- language is set to English (in File > Properties > Advanced)
- document reads logically when reflowed or rendered by text-to-speech software
- structural elements of document are properly tagged (headings, titles, lists etc)

- all images/figures have either alternative text or an appropriate caption
- tables are correctly tagged to represent the table structure
- text is left aligned, not justified
- document avoids excessive use of capitalised, underlined or italicised text
- hyperlinks are spelt out (e.g. in a footnote or endnote)

Datasets to support those to be published in the final report must be provided in an accessible format (CSV, Excel) on submission of the report.

Project Cost Guidelines

Where feasible, itemise the cost for each of the deliverables/methodologies in the bid.

Staff to Deliver Guidelines

Bidders should provide details of expertise relevant to this project for each member of the project team. The bids should also outline which team member will lead on which deliverable and how much time each member will contribute to the project.

Project Plan and Timescale Guidelines

The proposed high-level time table is below. Bidders should propose the overall project timeline and important milestones. In addition, they should outline how they will manage project delivery risks and ensure outputs will be delivered on time. If appropriate, add a short table with main delivery risk, potential risk owners and mitigation steps.

Project Start: March/April 2019

Interim Report: June 2019

Final report: September 2019

