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Evaluation of the Centre for Earth Observation Instrumentation (CEOI)

Final Report

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Preface

The UK Space Agency commissioned RAND Europe, **know**.space, Luca Budello and Aravind Ravichandran to deliver an evaluation of the Centre for Earth Observation Instrumentation (CEOI) programme from May 2023 to March 2025. The evaluation provided an assessment of the effectiveness of the CEOI's delivery (process), the extent to which it has achieved its objectives (perceived impact) and whether it represents value for money (economic).

Phase 1 of this study began with a deliverable scoping out this initial study phase, with a second deliverable presenting the monitoring and evaluation (M&E) literature review around space research and development (R&D), the initial baselining of the Earth Observation (EO) R&D sector when the CEOI programme launched in 2007, and the programme's process and stakeholder mapping. This study's third deliverable (the inception report) included all products presented in the second deliverable, with additional chapters developing the proposed approach to the evaluation.[1]

Phase 2 of this study commenced in June 2023 and ran until March 2025. It included interviews and surveys with CEOI programme project leads, partners and wider cross-government stakeholders to gain a better understanding of the CEOI programme's processes and impacts. The team also compiled a series of international case studies to provide insights into EO sectors in other countries, created and updated a baseline of the UK's EO sector, and conducted several policy roundtables. The interim findings from this stage were reported in mid-2024.[2]

This report constitutes the fifth and final deliverable, summarising the findings from Phase 2 of this study and synthesising overall findings.

For more information on this study, please contact the Project Lead, Billy Bryan (bbryan@randeurope.org).

[1] Khelifi et al. (2024).
[2] Ogden et al. (2024).

Summary

Earth Observation (EO) science is fundamental to humanity's understanding of our planet, its climate and its natural processes. Launched in 2007, the Earth Observation Instrumentation Programme (EOIP) aims to enhance the UK's capabilities in low Technology Readiness Level (TRL) Earth Observation (EO) instrumentation, with a focus on TRLs 3 and 4.[3] The programme also aims to fortify the position of UK-led teams in international contracts and export opportunities, particularly in European Space Agency (ESA) EO missions. The Centre for Earth Observation Instrumentation (CEOI), established in conjunction with the EOIP, has played a crucial role in delivering the programme. Initially funded by the Natural Environment Research Council (NERC), the EOIP advances UK technical capabilities in EO instrumentation. The EOIP was later expanded into the EO Technology Programme (EOTP) with an additional £15m up to March 2025 to develop innovative EO instrumentation and maintain the UK's position at the forefront of EO capability and expertise.

This final report presents the findings of the CEOI programme evaluation conducted by RAND Europe and know.space. It includes an overview of the UK EO sector and evaluates the programme's economics, processes and perceived impacts, exploring potential alternative delivery models. This report presents findings assessing the CEOI's perceived impacts, execution and value for money, aiming to understand how the programme has enhanced EO capabilities in the UK.

Contextualising the CEOI's results, this report's findings reveal the following about the UK EO sector today:

- The UK Space Agency has increased its overall spending on both national programmes and ESA contributions. In 2022, the UK increased investment in EO and climate programmes by 45% to counteract the impacts of the temporary withdrawal from EU components of the Copernicus programme.
- In 2021, EO satellite services supported industries, contributing £109bn of the UK's GDP (4.8%), demonstrating how EO can help underpin economic activity.
- By the financial year 2021/2022, the EO sector, including meteorology, contributed £784m to the UK space industry's overall £18.9bn income, marking a significant increase from previous years.
- The UK has more than doubled its investment in the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and remains actively engaged in international EO organisations such as the Committee on Earth Observation Satellites (CEOS), the European

[3] The TRL measures a technology's maturity, ranging from concept (TRL 1) to full operational capability (TRL 9), thereby aiding investment and decision-making.

Association of Remote Sensing Companies (EARSC), the European Space Sciences Committee (ESSC) and the Group on Earth Observations (GEO).

Key insights:

- The UK is a significant player in global EO technology development, and the CEOI plays a crucial role within the ecosystem.
- The CEOI programme funds innovative projects that lead to enhanced technological progression and promising mission concepts.

Interim programme impacts:

- The CEOI programme has been important in advancing the TRLs of UK-developed emerging EO capabilities by an average of 2.2 points, with many participants attributing significant project progress to the CEOI's support.
- Approximately 46.2% of survey respondents reported enhancements in their skills through participation in CEOI events. In comparison, 73.1% gained valuable technical insights from technology showcases facilitated by the programme.
- Some 69.2% of respondents indicated that CEOI funding has increased their ability to commercialise their research, and 96.2% reported gaining reputational benefits as a result of their involvement with the CEOI. Overall, participants widely acknowledged that their involvement with the CEOI has either maintained or enhanced their technical skills in developing innovative EO instruments.
- CEOI-supported technologies have featured on four successful satellite launches between 2015 and 2023, with seven additional launches currently in progress, five projects selected for further study and eleven more planned for future launches.
- Most respondents stated that the CEOI has strengthened their capacity to participate in international missions, while two-thirds acknowledged that the programme has enhanced their export capabilities.
- In addition to directly enabling increased TRLs, project stakeholders appreciate the CEOI for fostering collaboration and establishing pioneering partnerships, particularly between universities and private sector entities. Survey data indicate that industry collaborations frequently involve a broad network of additional stakeholders.
- The CEOI's strategic focus on supporting early-stage EO research and development (R&D) was identified as a key factor in maintaining the UK's EO capabilities.

Key insights:

- The CEOI fills an important gap in funding low-TRL UK EO projects and supporting their development to higher levels.
- The CEOI's expertise and networks enable coordination and collaboration among the government, academia and industry, thereby strengthening the UK EO and space sectors.
- The progression pipeline in international missions from CEOI-funded projects to ESA funding or involvement is evident, contributing to the UK's global standing.

Economic evaluation:

- The actual value for money of CEOI projects (the benefits relative to the costs) will only be realised in the long term, potentially years or even decades after the initial funding, due to the extended timelines required for incorporating early-stage technology development into EO missions. Nonetheless, there are some indications of potential for substantial future benefits, notably through several significant investment events.
- With the caveat that this economic evaluation of the CEOI programme only focuses on projects from roughly 2018 to 2025 (i.e. Calls 11–16) due to data limitations in earlier years, current estimates suggest that the real discounted Present Value (PV) of UK benefits from CEOI Calls 11–16 totals at least £30.2m to date. This value is primarily driven by three large ESA contracts. This PV benefit rises to at least £57.6m when expectations are included.
- The evaluation acknowledges that many significant benefits of CEOI, such as scientific progress, enhanced collaboration and spillover benefits to adjacent sectors, are non-monetisable, suggesting that quantitative estimates may underestimate the programme's full impact.

Key insights:

- Increasing funding for the CEOI could deliver further value to UK EO. Although project participants advocate for expanding the CEOI programme, potential challenges and trade-offs must be considered.
- Future monitoring will be essential to fully capture the programme's value for money. Regular ongoing monitoring, concurrent with project delivery, will be key to capturing benefits as they arise.

Process evaluation:

- Applicants greatly valued the CEOI's support for early-stage technology development. This key aspect of the programme addresses a critical funding gap for low-TRL innovations in the space sector, which often face high risks and low profitability.
- Interviewed project participants found the application process to be clear, rigorous, and characterised by quick turnaround times. The transparency of funding call needs and objectives, along with CEOI's responsiveness, was appreciated.
- Generally, participants expressed satisfaction with the CEOI's project management and reporting structures, including its light-touch process approach and regular updates to keep projects on track. Although there have been some reports of management delays, particularly during the COVID-19 pandemic, interviewed project leads reported overcoming these.
- Participants greatly valued the CEOI's programme design, which incorporates flexible funding tied to milestones and responsive communication. Although some academic project participants found the payment milestones and reporting timelines challenging, these generally aligned well with the project leads' needs and expectations.
- The CEOI funding and delivery model provides unique benefits to applicants and grant holders. It offers technical advice from the bid stage to the very end of the project, improving project designs and supporting ongoing R&D. This may not be the case with a traditional, centrally managed UK Space Agency programme, where there is less capacity to provide such embedded industry expertise. The trade-off between outsourcing costs and project quality currently favours quality. However,

work is needed to ensure that the CEOI has sufficient administrative and Monitoring and Evaluation (M&E) support to capture and share its benefits properly.

Key insights:

- The current CEOI model has advantages due to the level of stakeholder buy-in, programme transparency and support for international funding down the line.
- There is value in exploring alternative delivery models, such as an expanded, more centralised or fully centralised model delivered directly by the UK Space Agency. However, altering the programme's delivery is likely to have trade-offs that require further study.

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Abbreviations

AI	Artificial Intelligence
ARIA	Advanced Research and Invention Agency
BIS	Business, Innovation and Skills
BNSC	British National Space Centre
CDT	Centre for Doctoral Training
CEOI	Centre for Earth Observation Instrumentation
CEOS	Committee on Earth Observation Satellites
CHIME	Copernicus Hyperspectral Imaging Mission
CIMR	Copernicus Imaging Microwave Radiometer
COTS	Commercial Off the Shelf
CRISTAL	Copernicus Polar Ice and Snow Topography Altimeter
CSC	Copernicus Space Component
DASA	Defence and Security Accelerator
DBT	Department for Business and Trade
DESNZ	Department for Energy Security and Net Zero
DG	Directorates General
DIUS	Department for Innovation, Universities and Skills
DOSTAG	Data Operations Scientific and Technological Advisory Group
DS	Defence and Space
DSIT	Department for Science, Innovation and Technology
DSTL	Defence Science and Technology Laboratory
EASRC	European Association of Remote Sensing Companies
ECMWF	European Centre for Medium-Range Weather Forecasts
EO	Earth Observation

EOIP	Earth Observation Instrumentation Programme
EOITP	Earth Observation Technology Programme
EPS	Earth, Planets and Space
EPSRC	Engineering & Physical Sciences Research Council
ESA	European Space Agency
ESSEO	European Scientists on Spectrum for Earth Observation
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FORUM	Far-Infrared Outgoing Radiation Understanding and Monitoring
FTE	Full Time Equivalent
FWCI	Field-Weighted Citation Impact
FY	Financial Year
GDP	Gross Domestic Product
GEMINI-UK	Greenhouse Gas Emissions Monitoring Network to Inform Net Zero Initiatives for the UK
GEO	Group on Earth Observations
GMES	Global Monitoring for Environment and Security
GSR	Government Social Research
GVA	Gross Value Added
IASI-NG	Infrared Atmospheric Sounding Interferometer New Generation
IBF	International Bilateral Fund
IP	Intellectual Property
LOCUS	Linking Observations of Climate, the Upper Atmosphere and Space Weather
LSTM	Land Surface Temperature Monitoring
METOP-SG	Meteorological Operational Satellite – Second Generation
MOD	Ministry of Defence
MOSWOC	Met Office Space Weather Operations Centre
MWIR	Mid-Wave Infrared Thermal Imagers
NASA	National Aeronautics and Space Administration
NCEO	National Centre for Earth Observation
NERC	Natural Environment Research Council

NPL	National Physical Laboratory
NPSV	Net Present Social Value
NSIP	Nationally Significant Infrastructure Projects
NSS	National Space Strategy
ONS	Office for National Statistics
PV	Present Value
RAL	Rutherford Appleton Laboratory
ROSE-L	Radar Observing System for Europe in L-Band
SAR	Subject Access Request
SENSE	Satellite Data in Environmental Science
SPIN	Satellite Applications Catapult's Space Placements in Industry
SSTL	Surrey Space Technologies Ltd
STEM	Science, Technology, Engineering and Mathematics
STFC	Science and Technology Facilities Council
SWOT	Surface Water and Ocean Topography
TRL	Technology Readiness Level
TRUTHS	Traceable Radiometry Underpinning Terrestrial- and Helio-Studies
UAV	Uncrewed Aerial Vehicle
UK	United Kingdom
UKRI	United Kingdom Research and Innovation
UVNS	Ultraviolet Visible Near-Infrared Short-wave Infrared Spectrometer
WECD	Warwick Economics & Developments

1. Introduction

1.1. The CEOI programme

The Earth Observation Instrumentation Programme (EOIP) was launched in 2007 to maintain and grow the UK's capability in instrumentation for low-Technology Readiness Level (TRL) Earth Observation (EO) up to TRLs 3 or 4.[4] The EOIP aims to strengthen the position of UK-led teams bidding for export opportunities and international contracts, particularly in ESA EO missions. The Centre for Earth Observation Instrumentation (CEOI) has overseen the EOIP since its inception in 2007. The Natural Environment Research Council (NERC) initiated the EOIP to help develop UK technical capability in innovative EO instrumentation and offer a strategic funding source to this end. The CEOI consortium, which has delivered the programme, is led by Airbus Defence and Space (DS) in partnership with QinetiQ, the University of Leicester, the Science and Technology Facilities Council's (STFC's) Rutherford Appleton Laboratory (RAL Space), and, more recently, know.space. The consortium aims to develop innovative technologies to observe Earth from space by teaming UK scientists with industrialists. Founded in 2010, the UK Space Agency assumed responsibility for EOIP funding from NERC.

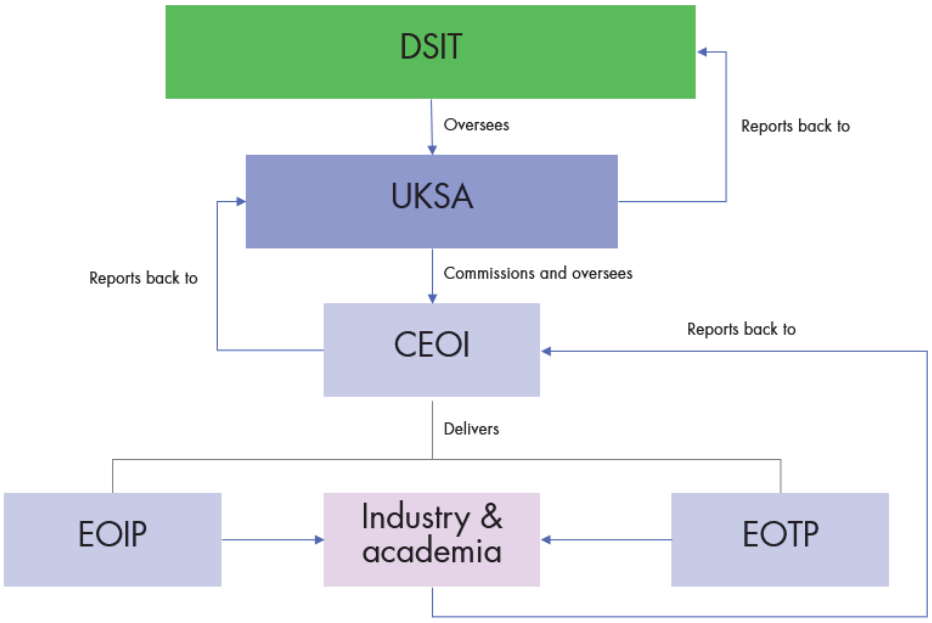
To date, there have been two primary elements to the EOIP:

- **The Technology Programme** comprised 74 projects funded through 16 themed/open Research and Development (R&D) grant funding calls, funding a wide range of technologies.
- **The Added Value Programme** comprised knowledge-exchange and networking events to establish and strengthen academic-industry networks, providing advice to upskill and guide companies bidding for ESA projects alongside strategic/technical advice for the UK Space Agency, the DSIT and the wider government.

Announced in November 2022, the EO Technology Programme (EOTP)[5] was designed to develop innovative EO satellite instrumentation, maintaining the UK's position at the forefront of EO capability and expertise. By co-funding innovation with industry and academia, the programme aims to help mature technologies form part of satellite mission payloads or viable commercial applications. Figure 1 outlines a simple view of the CEOI's governance structure.

[4] 'Low-TRL' technologies are those in the early stage of development, i.e. concepts or models that may not yet have been tested or prototyped.
[5] HMG (2022).

Figure 1: The CEOI's governance structure



Source: RAND Europe analysis of UK Space Agency documentation on CEOI.

The EOTP enabled the EOIP's scale-up and delivery by expanding the existing CEOI contract. The EOTP aims to enable the development of select technologies beyond what was previously possible, potentially including airborne and/or in-orbit demonstrations to prove capability and provide additional support to lower-level TRL projects. The EOTP also expands on the EOIP's objectives, focusing more on closer-to-market technologies and the ESA's and other international space agencies' adoption rate of EOTP/EOIP-supported projects. It also recognises the need to mitigate the economic impact of the period of non-association with Copernicus, the European Union (EU) EO programme, which the UK rejoined as an associate country in 2024.[6]

In 2017, the CEOI prepared the UK EO technology strategy[7] for the UK Space Agency, outlining the UK Space Agency's EO vision over the next decade to help the UK become a world leader in new EO technologies. The strategy was updated in 2019 and outlined four key objectives underpinning EOIP/EOTP-funded activities:

- **Economic Impact:** Develop EO technologies that increase exports and economic growth.
- **Innovation:** Keep the UK at the forefront of EO technology development by supporting new and innovative ideas that offer tangible benefits to future missions.
- **Capability:** Strengthen capabilities in which the UK already leads, has the potential to lead or could overtake existing capability elsewhere.

[6] HMG (2023).
[7] UK Space Agency (2017a).

- **Return on UK Government Investment:** Maximise the benefits derived from UK funding to ESA and other institutional bodies.

This report refers hereon to the CEOI programme as a combination of the EOIP, the EOTP and the CEOI delivery consortium.

1.2. Study objectives

This evaluation aimed to assess the CEOI's impact, delivery and value for money, and to understand how both programmes contribute to improving the UK's EO capabilities. The overall objective was to deliver an impact, process and economic evaluation across the CEOI to optimise the programme's ongoing delivery.

Guided by His Majesty's Government's (HMG) Magenta, Green & Aqua Books' best practices and Government Social Research (GSR) ethics guidelines, the monitoring and evaluation (M&E) activity funded through this project aims to help the UK Space Agency understand how effective funding from CEOI has been by establishing what tangible difference it has made and for whom (direct beneficiaries, associated or non-participating organisations and broader society). It also gathered lessons learned to support the design and implementation of future programmes and the CEOI's next steps.

However, the methodology used for the impact evaluation is not sufficiently robust to be termed a proper impact evaluation in line with HMG guidance. An *impact evaluation* and assessment of concrete impacts typically involves the deployment of quasi-experimental methods and the identification of a proper counterfactual or control group, which are not utilised here due to data availability constraints and the absence of a well-defined control. Instead, this work employs a theory-based approach, identifying *perceived* or *interim impacts.* For simplicity, we continue to refer to 'impacts' throughout this report; however, this caveat should be kept in mind.

The evaluation involved extensive primary and secondary research, underpinned by a Theory of Change (ToC) and process map. A previous evaluation of CEOI was conducted in 2022, covering the period from the CEOI's inception until 2021. Rather than duplicating that effort, this evaluation extended and tested those findings by revisiting the impact of CEOI projects to date. Our approach to assessing the impact of the programme was primarily centred around contribution analysis (CA) to test the claims set out in the ToC and evaluation framework. By employing CA, we aimed to develop a framework for understanding how the CEOI contributed to observed outcomes in the ToC. To build a strong basis for the evaluation, we implemented an impact indicator framework that detailed the metrics to be used in answering the evaluation questions. From this, indicators and evaluation questions were synthesised to underpin specific interview questions, data analysis and bibliometric analysis. We report results broadly against the original contribution claims, detailing the level of attribution to the CEOI intervention.

M&E and benefits management ensure the optimal allocation of public funds to benefit a wide range of UK stakeholders (e.g. industry, academia, and the general public) and contribute to achieving national and regional strategic objectives, especially those outlined in the National Space Strategy (NSS). The UK Space Agency's North Star metric utilises the total investment level and contract revenue brought into the UK space sector to assess the sector's overall value. Doing so effectively requires data collection from the outset

to support and evidence the UK Space Agency's evaluations in the coming decade, providing transparency on how the UK benefits from this investment and lessons for the future.

1.3. Methodology

This study phase involved multiple data collection and synthesis methods, as detailed in the section below.

Table 1: Methodologies across each evaluation stream

Method category	Methods used
Process evaluation	Surveys
	Interviews
	Policy round tables
Economic evaluation	Secondary data analysis
	Monitoring forms
Data science	Bibliometrics

Source: Internal document repository.

1.3.1. Process Evaluation

The process evaluation of the CEOI focuses on using contribution analysis (CA), based on theories of change (ToC) analysis, as part of a theory-based approach. This approach explores programme hypotheses and alternative hypotheses by creating a contribution story derived from key stakeholders and participatory methods, including surveys, interviews and policy roundtables. Stakeholder surveys, policy roundtables and CEOI participant interviews were utilised for impact analysis, with an interview with CEOI centred around process evaluation itself. The addition of contribution stories through qualitative data gathering enables the implementation of theory during design and provides strong evaluation outcomes based on actual stakeholder feedback. An overview of the methods used for the process evaluation follows below:

- **Survey:** Between November 2023 and February 2024, we circulated an online survey through SmartSurvey to project leads and partners from all projects funded by the CEOI since its inception. The questionnaire covered process and impact questions, asking respondents to indicate the level of support they received from CEOI for their projects and to identify their TRL progression rate, along with core questions around their experience with CEOI processes (See Annex B for survey questions). Of 68 project leads, 26 responded (38.2% response rate). This low response rate is attributable to the sector's relatively high turnover, the project teams' demanding workloads and 'survey fatigue', as stakeholders had already participated in surveys for previous and concurrent evaluations. We focused more on our interviews and document review to cover gaps.
- **Interviews:** Interviews were the primary data collection method for capturing the rich, qualitative data needed to answer the evaluation questions (EQs). Interviews were semi-structured, using clearly defined topic guides that reflected survey topics. We conducted a total of 26 online interviews via Teams across four stakeholder types: the wider programme team (e.g. CEOI and UK Space Agency EO policy leads, n=5), project leads (n=10), other beneficiaries (e.g. project partners, n=3) and wider policy stakeholders, e.g. the Defence Science and Technology Laboratory (DSTL)

and ESA (n=7). We conducted the analysis in MAXQDA and grouped the results thematically by the indicator frameworks.

- **Policy roundtables:** The study team also held two policy roundtables with practitioners within the UK EO sector and government stakeholders working on EO policy, R&D and strategy. Organisations and departments attending the EO sector roundtables included the UK Space Agency, DSIT, DEFRA, the Met Office, National Physical Laboratory, the STFC's RAL Space, Surrey Satellite Technology Ltd (SSTL), ESA and UKRI. We held the two roundtables on 23 October 2024 and 6 November 2024 via Teams. The sessions discussed the UK's strengths and gaps in the EO market, key past trends in the UK's domestic and international EO policy and programmes, opportunities for EO investment, future needs and strategies, job creation and the ideal delivery model for EO sector funding. The discussion from the roundtables helped validate findings and add qualitative strength to the evaluation.

1.3.2. Economic Evaluation

Our economic evaluation combined qualitative and quantitative evidence to assess the extent to which the CEOI has provided value for money. We collated data on costs and benefits, using cost data provided by the CEOI and data on benefits from monitoring forms, the survey, and, to a lesser extent, interviews. We made adjustments for additionality, attribution, deadweight, displacement and leakage, as well as appropriately discounting and deflating figures.

- **Secondary data analysis:** We analysed secondary data from various sources, reporting descriptive information about the projects and application numbers via the CEOI's programme data and feeding this into a portfolio analysis to help contextualise the results. The CEOI-supplied documentation included project reports, quarterly reports and selection panel results. However, the documentation was unevenly distributed across the funding calls, with only 59% of projects having available reports. Table 2 below shows the documentation received across each funding round.

Table 2: CEOI documentation received

	Rounds 1–6	Round 7	Round 8	Round 9	Round 10	Round 11	Round 12
Number of projects	18	16	6	6	18	7	12
Number of projects with reports available	9	15	4	5	11	2	3
Share of projects with reports available	50%	94%	67%	83%	61%	29%	25%

Source: Internal document repository.

- **Monitoring forms:** The research team designed monitoring forms in consultation with UK Space Agency and the CEOI to capture economic data among project participants. The forms collected project information, including the value of CEOI funding, match funding and the start and end TRLs. The forms were designed to be issued periodically to project stakeholders, enabling the CEOI to gather economic data on a rolling basis to fulfil North Star Metric reporting requirements.

1.3.3. Data Science

We employed data science methods as a quantitative mechanism for analysing the CEOI's impact and adopted a bibliometrics methodology over alternatives, such as altmetrics, due to data scarcity and temporal constraints on the research team. Our rationale was that open-source data can be used to obtain information on key impact parameters, such as publication counts, FWCI, and the number of publications by year, as well as those in the top 1% of their respective fields. [8] We outline our specific method below:

- **Bibliometrics:** We conducted a bibliometric analysis to understand the UK's contribution to international research on EO technologies. Due to challenges in attributing research outputs specifically to the CEOI programme, the focus was on the UK's overall position in EO research. We selected the OpenAlex database for its completeness.[9] The process of filtering UK-related EO publications was iterative, focusing on papers from 2006 to 2023 and using specific search terms to identify relevant research. The research team manually reviewed results from different search term combinations, adjusting them to maximise the inclusion of relevant papers. The search, conducted on 19 November 2024, yielded 37,140 journal articles. We created additional datasets for the UK, France, Germany, Canada, Japan, Australia, South Korea, Norway and Finland based on this one to compare their presence in EO research. This approach benchmarks the UK's performance against these countries. We also selected publications from several UK institutions to assess their performance against scientometric indicators. Box 1 shows the search terms used in OpenAlex for this study.

Box 1. Search terms used in OpenAlex

Terms: "earth observation" AND ("satellite" OR "ir radiometry" OR "optical imaging" OR "ir spectroscopy" OR "lidar" OR "optical spectroscopy" OR "passive microwave" OR "radiation detection" OR "gnss-r" OR "spatial resolution" OR "radar altimetry" OR "radar scatterometry")

Full OpenAlex query

1.4. Caveats and limitations

There were several challenges in conducting this evaluation that should be kept in mind when considering the results:

- **Reporting gaps:** The secondary data analysis in this research was limited by the availability of project reporting. Funding values for early calls (those made before the seventh call) were stored in secure commercial servers that have not yet been migrated to the new system due to the CEOI leadership's transformation under the UK Space Agency. As such, we have aggregated figures for these projects.

[8] Altmetrics is a form of more inclusive bibliometrics that relies on scraping data from social media, patent submissions, non-scholarly forums, mainstream media, policy documents and social networks. However, it is incredibly time-intensive and requires advanced data scraping methods to replace normalised bibliometrics meaningfully. For more detail, see Pavlović (2020).

[9] For analyses of OpenAlex's completeness relative to other bibliographic databases, see Culbert et al (2024).

- **Low survey response:** Since the initial survey achieved a response rate of only 38.2%, we pivoted to conducting interviews, which gathered more qualitative data. The interviews yielded a better response rate and enabled participants to tell the story of their project and the CEOI's impact.
- **Low monitoring form response**: Less than a third of the total grantee population returned the monitoring forms, limiting the insights we could draw from across the portfolio, particularly for the economic evaluation. This low response was despite the mandatory requirement, since 2022, for projects to report data on the North Star Metrics, addressed within the monitoring form.
- **Retrospective recall:** Reaching stakeholders for projects awarded over 15 years ago has been challenging, which may have also impacted the response rate. Project leads were interviewed and surveyed as part of the CEOI evaluations. However, this report relies heavily on documentary and secondary data sources to minimise the need for questioning in surveys and interviews.
- **Measuring impact:** This involves considerable challenges linked to the nature of the funded innovation. Across many programmes, scientific impact is expected but has yet to materialise. Intellectual property (IP) products and publications may not yet have been generated in some cases.
- **Self-reported TRL:** There are certain limitations in this and previous methods of evaluating the CEOI, particularly regarding project leads self-assessing their projects' TRL changes. Without a clear definition of TRLs, stakeholders might evaluate their projects' TRLs differently, impacting reporting accuracy and hindering cross-comparability. Organisations may also feel compelled to report TRL increases to justify their CEOI funding. Future evaluations may benefit from employing a third party (e.g. a peer review panel) to compile and assess this data.
- **Varied outputs:** Outputs may vary depending on the project and lead type (e.g. commercial, academic or government). Some projects – particularly those with an academic lead – prioritise publications over generating IP. Others prioritise product commercialisation without releasing findings into the public domain.
- **Evaluation timelines:** The study team encountered challenges in gauging outputs at this evaluation stage, particularly for those that had not yet materialised. While some completed projects had already achieved their intended outputs or outcomes, others were slower to materialise due to longer causal pathways between the project's output and national-scale impact. Other projects are ongoing, with further awards pending. Therefore, their expected outputs are unlikely to manifest until later in the evaluation.
- **M&E was not in the CEOI's original scope**: Including M&E post-award has led to inconsistent responses and a lack of baseline data for each project. This issue is further complicated by the time constraints that CEOI staff face. The M&E reporting expectations outlined in the GFA should be expanded to include clear guidelines on data collection, storage and transfer to evaluators.

2. The UK EO sector today

2.1. Summary

EO remains a strategic priority for the UK, identified as a 'high growth area' in the National Space Strategy[10] and reinforced in the National Space Strategy in Action (2023). The UK Space Agency has increased national and ESA spending, investing more in EO to mitigate impacts from the short-term exit from EU elements of Copernicus. The UK has re-engaged with the EU arm of Copernicus to ensure participation in key space initiatives and strengthen its position in European EO activities. The UK Space Agency primarily delivers through the ESA and contributes to several international EO missions. However, the UK EO sector faces challenges, such as skills shortages, and requires targeted strategies and long-term funding to enhance growth and innovation.

Box 2: Quick figures on the UK EO sector, past and present

- In 2021/2022, the EO sector, including meteorology, contributed £784m to the UK space industry's £18.9bn income.
- In 2021, EO satellite services supported industries that contribute £109bn to UK GDP (4.8%).
- The UK has more than doubled its investment in EUMETSAT and continues to participate in international EO organisations such as the Committee on Earth Observation Satellites (CEOS), EASRC, European Scientists on Spectrum for Earth Observation (ESSEO) and the Group on Earth Observations (GEO).

2.2. Context

Since 2007, the UK EO sector has grown through strategic investments, technological advancements and increased international collaboration. The British National Space Centre (BNSC) previously coordinated and funded UK space activities. However, the UK Space Agency was established in 2011 as the government's primary delivery agency for UK civil space programmes, including overseeing the CEOI programme.[11] The Department for Science, Innovation and Technology (DSIT) sits above the UK Space Agency, setting civil space policy.[12]

Government funding for the space sector has also increased since 2007, reflecting a growing commitment to enhancing the UK's space capabilities. National spending rose from £21m in 2010/2011[13] to £102m in

[10] HMG (2021).

[11] UK Space Agency (2012c).

[12] NAO (2024a).

[13] UK Space Agency (2012b). Value in current price.

2023/2024.[14] Over the same period, the UK's total contributions to ESA have more than doubled from £217m[15] to £482m.[16] In 2021/2022, EO satellite services supported industries that contribute £109bn to UK GDP (4.8%), demonstrating how EO can help underpin economic activities.[17] It also highlights EO's expanding role in decision-making, risk assessment and sustainability efforts, reinforcing its strategic importance to the UK economy.

Since 2007, EO has been a strategic priority for the UK Space Agency and the UK's space ambitions, with policies aimed at maintaining global leadership in EO capabilities. The *2010 Space Innovation and Growth Strategy*[18] identified EO as a major growth area, leading to the *Strategy for Earth Observation from Space 2013–16.*[19] This strategy focused on enhancing international EO leadership through collaboration among academia, government and industry, improving EO technology and data accessibility. It aimed to maximise returns from UK membership in European programmes, including ESA and EU space subscriptions. In 2019, the *UK EO Technology Strategy*[20] was published to guide investment in upstream technologies for future EO missions, emphasising returns from international programmes like ESA and Copernicus. It prioritised developing technologies relevant to future EO missions to strengthen the UK's position in national, European and global initiatives.

Published in 2021, the NSS,[21] the UK's first Space Strategy, identified EO as a key sector for capability development. The *2023 National Space Strategy in Action*[22] outlined steps to maintain leadership in EO technology, including creating a national EO strategy, enhancing government EO data use and integrating civil and defence activities. Priorities include advancements in EO technology, especially small satellites, and developing a robust EO data ecosystem. The UK aims to become a global hub for high-quality EO data and leverage EO for climate, weather and environmental challenges. International collaboration, particularly with ESA, EUMETSAT, the EU and Five Eyes, is essential to fulfilling these objectives.

The EO sector has faced significant challenges since 2007. The UK's exit from the EU introduced uncertainty regarding the UK's access to the Copernicus programme, the EO component of the EU's space programme, with the UK's membership temporarily paused between 2021 and 2024. As a result, UK institutions were unable to participate in Copernicus projects or receive funding, and projects progressed without UK involvement. Meanwhile, funding fluctuations and a demand for specialised skills also impacted the sector's growth.

2.3. Funding and spending

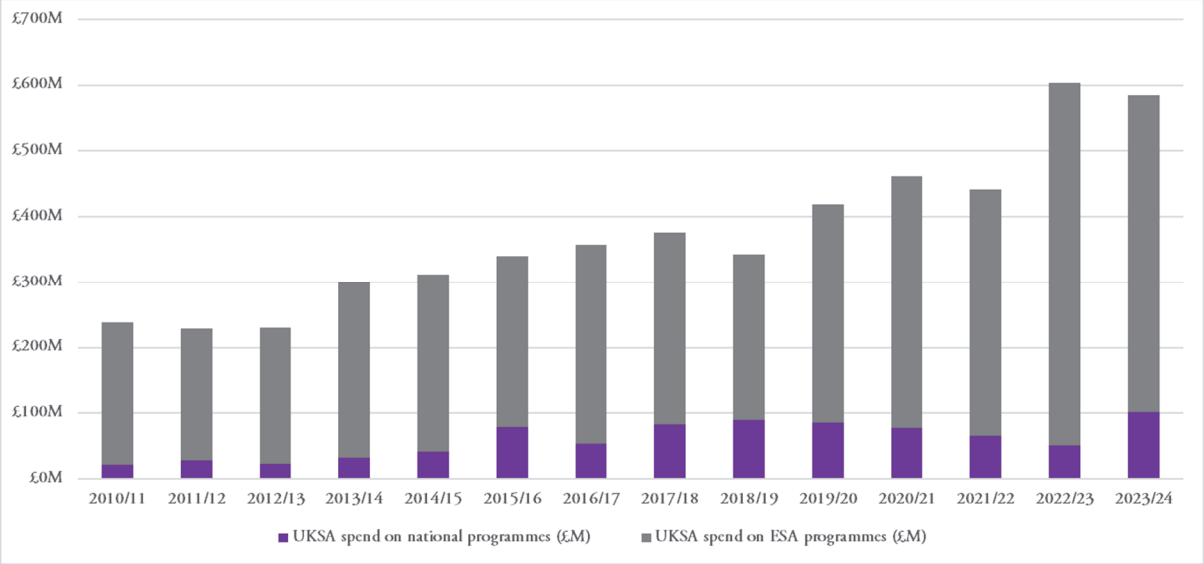
Since its inception in 2011, the UK Space Agency's budget allocation has grown consistently, channelling most spending through the ESA. National expenditure increased from £21m in 2010/2011 to £102m in

[14] UK Space Agency (2024b). Value in current price.
[15] UK Space Agency (2012b). Value in current price.
[16] UK Space Agency (2024b). Value in current price.
[17] UK Space Agency (2024c).
[18] Space IGS (2010).
[19] UK Space Agency (2013).
[20] CEOI (2019).
[21] UK Space Agency et al. (2021).
[22] DSIT & MoD (2023).

2023/2024, while ESA contributions rose from £217m to £482m over the same period.[23] The CEOI is a key EO-specific funding programme, complemented by broader funding opportunities, such as the UK Space Agency's International Bilateral Fund (IBF) and the National Space Innovation Programme (NSIP), which support EO projects and foster innovation. Besides the UK Space Agency, other public bodies, such as UKRI and its subordinate STFC and NERC, play crucial roles in EO funding and collaboration, [24] in addition to the Met Office. The Dstl also contributes significantly to UK space research, focusing on space technology for defence and security.[25]

The figure below illustrates the temporal trend in general the UK Space Agency's expenditure, demonstrating its increasing national importance. A breakdown at the EO level is difficult to identify, not least due to a lack of data and the way EO activities are often integrated within non-EO-specific programmes.

Figure 2: UK Space Agency expenditure on national and ESA programmes[26]



Source: UK Space Agency Annual Report and Accounts 2011/2012–2023/2024 (see References for the complete list).

While detailed EO-specific data is limited, increased national space expenditure and ESA contributions suggest a rise in EO-related spending. Recently, the UK government committed to supporting the EO sector in meeting NSS goals and addressing funding challenges resulting from the temporary Copernicus suspension. A £187.6m investment was announced in 2022, repurposing funds initially allocated for the Copernicus project. This investment included £65m to develop UK EO capabilities, fostering innovation and strengthening the domestic EO ecosystem, and £122.6m for ESA EO programmes, securing international collaboration.[27] This strategic redistribution of funds underscores the UK's commitment to maintaining its leadership in EO amid geopolitical uncertainties. A further £47m investment was

[23] UK Space Agency (2012b); UK Space Agency (2024b). Values are in current prices.
[24] UKRI (2025a).
[25] DSIT & MoD (2023).
[26] These values are in current prices.
[27] BEIS et al. (2022).

announced in 2023, building on the 2022 deal, with £41.7m through ESA and £1.1m via the STFC and NERC, underscoring the UK's commitment to EO leadership.[28]

Table 3 below showcases the UK Space Agency's increased spending on national programmes from 2022/2023 onwards. The decrease in EO spending from 2022/2023 to 2023/2024 reflects lower ring-fenced funding for the Earth Observation investment package, which was announced to support the UK EO sector during the temporary pause in Copernicus membership. The EO investment package's value was £123.1m in 2022/2023 and just £46.3m in 2023/2024. Of the ring-fenced EO budget, the UK Space Agency spent £4.7m on funding CEOI and £41.6m on ESA programmes in 2023/2024. The EO investment package spending for 2024/2025 has been further reduced, as the UK has now fully rejoined the Copernicus programme.[29] EO remains the third largest programmatic expenditure in 2024/2025, underscoring its strategic importance and sustained investment focus within the UK Space Agency's overall budget.

Table 3: Spend trends from 2022/2023 to 2024/2025

UK Space Agency Priorities	2022/2023 Actuals (£m)	2023/2024 Actuals (£m)	2024/2025 Allocation (£m)
EO	213.8	152.0	90
Discovery	217.4	247.3	233
Sustainability	44.4	48.0	41
Levelling up	N/A	15.0	54
Innovation	145.1	167.8	151
Low Earth orbit	N/A	N/A	N/A
Inspiration	N/A	N/A	N/A
Launch[30]	22	8	13

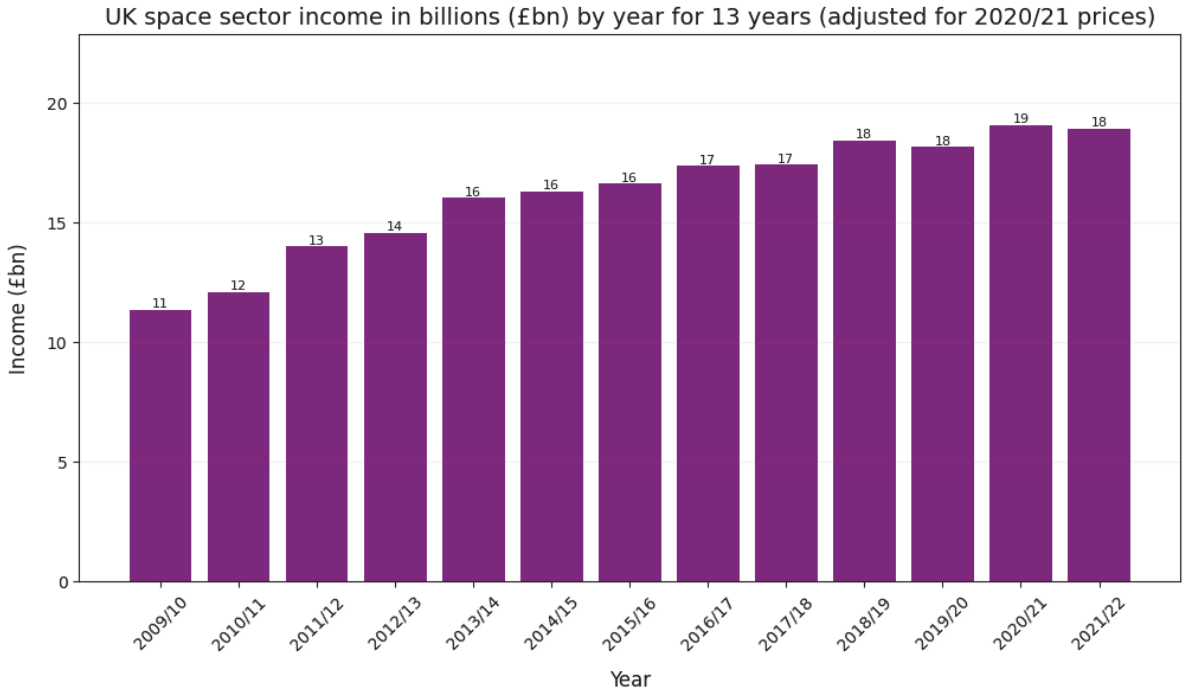
Source: UK Space Agency (2024a).

2.4. Capabilities

The UK's space-related income was estimated at £11.3bn in 2009/2010. By 2021/2022, total industry income had increased to £18.9bn, including £733m from the EO sector and £51m from meteorology. Medium-term sector growth has been strong, with income increasing by 2.7% between 2018/2019 and 2021/2022.[31]

[28] DSIT et al.. (2022).
[29] UK Space Agency (2024b).
[30] UK Space Agency (2023b).
[31] UK Space Agency (2024c). Values in current prices.

Figure 3: Trends in UK space industry income (adjusted to 2020/2021 prices)

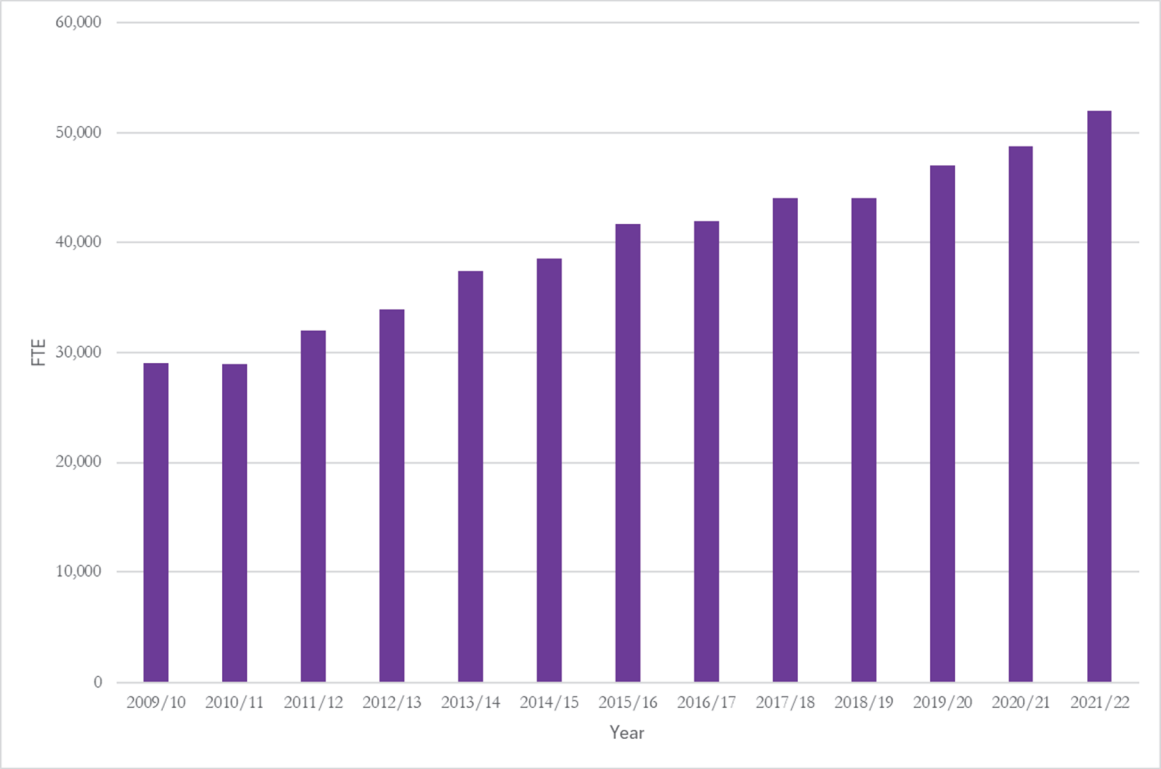


Source: UK Space Agency (2023).

There has been a gradual increase in total employment in the UK space industry with 52,028 Full Time Equivalent (FTE) in 2021/2022, compared to 28,995 FTEs in 2009/2010. This figure includes 10,586 employees within the space manufacturing segment and 4,914 employees within the space operations segment during the 2021/2022 period. Employment grew approximately 5% in 2021/2022.[32] There were 432 UK space organisations with some EO activities in 2020/2021, with an estimated 2,820 FTE jobs in EO.[33]

[32] UK Space Agency (2024c).
[33] know.space estimates using proprietary know.space databases.

Figure 4: Employment trends in the UK space industry



Source: UK Space Agency (2023).

2.4.1. Skills and Training

The UK space sector is characterised by a highly skilled workforce, although specific data on EO skills is more limited. Most space industry employees have a university education, with 80% holding at least a bachelor's degree.[34] The average qualification level in the space industry exceeds that of any sector reported in the Office for National Statistics (ONS) Census data. Still, the sector faces significant barriers in aligning workforce capabilities with demand, and skills shortages remain a key challenge. The Space Sector Skills Survey showed that 52% of organisations reported workforce skills gaps in 2023, highlighting the persistent nature of this challenge for the UK space industry.[35] Whilst these challenges are not specific to CEOI-funded organisations, or even just the EO sector, CEOI-funded projects must operate within this broader context. In general, EO-funded organisations may face challenges expanding or recruiting due to these skills shortages.

Since 2007, several initiatives have been launched to help build a skilled workforce and support the sector's growth. In collaboration with the UK Space Agency, the Satellite Applications Catapult's Space Placements in Industry (SPIN) programme has facilitated nearly 450 space-sector work placements over the past decade, with 75% of alumni entering space or tech fields.[36] The Satellite Data in Environmental Science (SENSE) Centre for Doctoral Training (CDT), launched in 2020 by the Universities of Edinburgh and Leeds and funded by NERC and the UK Space Agency, is training 69 PhD students to tackle environmental

[34] UK Space Agency (2024c).
[35] UK Space Agency (2021c); UK Space Agency (2023c).
[36] UKRI (2025b).

challenges using satellite data and EO methods.[37] Additionally, the Engineering and Physical Sciences Research Council (EPSRC) CDT for Geospatial Systems, in partnership with Newcastle University, the University of Nottingham, and UKRI, trains doctoral students to enhance the UK's economic benefits from open geospatial data.

2.5. National EO activities

Since 2007, the UK has funded national EO activities, including UK-led missions and grant schemes like the CEOI, enhancing core capabilities and fostering sector growth. These efforts have advanced satellite technology and improved data acquisition for environmental monitoring. Notable missions include the NovaSAR satellite, funded with £21m by the UK Space Agency in 2011, designed for flood, forest and disaster monitoring.[38] Another key mission was UKube-1, the UK's first national CubeSat, built by AAC Clyde Space and launched in July 2014, which successfully demonstrated technology deployment and data collection.[39]

Major UK industrial stakeholders have also played critical roles in supporting and delivering EO missions, reinforcing the private sector's capacity for innovation. For example, Carbonite-1 (2015–2018) was a technology demonstration mission developed by SSTL designed to showcase low-cost, high-performance video imaging applications. The mission achieved its objective by demonstrating the viability of a commercial-off-the-shelf (COTS) imaging payload.[40]

Since its establishment, the National Centre for Earth Observation (NCEO) has enabled the advancement of several UK EO capabilities. The NCEO was established in 2014 as part of NERC, dedicated to the long-term study and exploitation of EO data to generate new knowledge about Earth's physical, chemical and biological systems.[41] NCEO scientists are playing key roles in recently launched and upcoming satellite missions, such as ESA's BIOMASS (launched April 2025), EarthCARE (launched May 2024), FORUM and TRUTHS missions and the joint UK Space Agency/CNES MicroCarb (launched July 2025), contributing to mission design, sensor development, system and data analysis, modelling, algorithm creation and validation.[42]

2.6. International collaborations and partnerships

Since 2007, the UK has continued its membership in international organisations, including ESA, EUMETSAT, Copernicus (with a temporary pause), GEO and CEOS – of which the UK assumed the Chair in October 2024 for 12 months. The UK maintains a strong involvement in European EO activities through industry and policy engagement. Several UK companies are active members of the European Association of Remote Sensing Companies (EARSC), contributing to advancements in remote sensing and geo-information services.[43] The UK also has representation at the European Scientists on Spectrum for

[37] SENSE (2025a).
[38] UK Space Agency (2012c).
[39] UK Space Agency (2015b).
[40] eoPortal (2018).
[41] NCEO (2025d).
[42] NCEO (2025a).
[43] EASRC (2025a).

Earth Observation (ESSEO), a group of senior scientists shaping the European science community's views on frequency regulatory matters in Earth science, meteorology and climate,[44] ensuring continued influence in continental initiatives. This participation underscores the UK's strategic commitment to remaining at the forefront of international EO.

2.6.1. ESA

As in 2007, the UK channels most of its EO activities through its subscription to ESA programmes. The UK Space Agency invests in ESA because its technical expertise, knowledge and test facilities offer opportunities to strengthen national capabilities and expand the UK space sector.[45] Between 2010/2011 and 2023/2024, the UK Space Agency increased its expenditure on ESA subscriptions from £217m to £482m.[46]

We estimated that the UK Space Agency's subscription to ESA's EO portfolio increased from approximately £41.014m in 2013 to £46.9m in 2016.[47] During this time, the country's EO subscription remained steady at around 16% of the UK Space Agency's overall contribution to ESA programmes. In 2013, in addition to the EO subscription, other key EO-related activities include GMES (Global Monitoring for Environment and Security – the precursor to Copernicus), with an estimated contribution of £7.6m, and MetOP-SG with an estimated contribution of £20.1m. GMES included initiatives focused on environmental management, understanding and mitigating the effects of climate change and ensuring civil security.[48] Furthermore, the MetOp-SG satellites serve as the second-generation meteorological satellites for EUMETSAT, providing detailed global observations for weather and climate.[49]

Between 2017/2018 and 2023/2024, the UK consistently spent around 20–24.5% of its overall subscription on EO activities. We estimated that the UK Space Agency's subscription to ESA's EO portfolio rose from £64.4m in 2017/2018 to £111.4m in 2023/2024.[50] Investments in ESA, including the Earth Observation Envelope Programme (EOEP), have provided the UK with the opportunity to contribute to, and in some cases play a leading role in, large-scale missions. One high-profile example is the UK-led Traceable Radiometry Underpinning Terrestrial- and Helio-Studies (TRUTHS) mission – the country's first ESA EarthWatch mission, due to launch in 2030.[51] It aims to establish a space-based observatory for climate and calibration, thereby enhancing the accuracy of climate measurements and supporting strategies for achieving net-zero emissions, as well as assessing their impact. Airbus UK is leading the implementation phase of the mission under an ESA contract, following the successful completion of the feasibility and pre-development phases in 2022. Along with other UK organisations, the National Physical Laboratory (NPL) and Teledyne e2v Space Imaging are contributing key technologies, calibration support and scientific

[44] ESA (2025a).
[45] NAO (2024b).
[46] See all UK Space Agency resources for data in the References (values in current prices).
[47] know.space analysis. UK Space Agency (2014b, 2015, 2016a) - calendar years used to reflect UK Space Agency annual reports reporting (values in current prices).
[48] ESA (2012).
[49] EUMETSAT (2025a).
[50] See all UK Space Agency resources for data in the References (values in current prices).
[51] UK Space Agency (2020).

expertise to optimise the mission's data accuracy and overall performance.[52] The CEOI directly contributed to this success, funding the early TRL-raising of the TRUTHS radiometer and calibration system.[53]

2.6.2. The EU and Copernicus

Beyond ESA, the UK has had significant involvement in high-profile European programmes and missions over the past decade, notably the Copernicus programme. The UK was actively involved in the Copernicus (previously GMES) programme from its inception.[54] However, the UK's exit from the EU created uncertainty about whether UK organisations could bid for Copernicus contracts, given that it is an EU-funded programme. Whilst the UK continued to be associated with the ESA arm – the Copernicus Space Component (CSC-4) – there was ambiguity about whether UK organisations could bid for Copernicus contracts tendered through ECMWF[55] and Mercator Ocean.[56] The UK was also limited to using lower-resolution open-source Copernicus data, meaning these satellites were primarily useful for climate monitoring rather than sensitive security missions.[57]

During this period of uncertainty about the UK's future in the Copernicus programme, the UK government announced a £187.6m investment package in 2022 to support EO activities, followed by a further £47m in FY2023/2024.[58] In 2023, three years after exiting the EU, the UK secured a revised agreement to rejoin the Copernicus programme. While we do not know the specifics for Copernicus only, the European Commission estimates that the UK will contribute almost £2.18bn (€2.6bn) per year on average for its participation in both Horizon Europe and the Copernicus component of the Space programme.[59] This milestone reinstated UK organisations' eligibility to compete for Copernicus contracts. Additionally, the deal restored full access to the programme's resources and high-impact projects, reinforcing the UK's role in European EO initiatives.[60]

2.6.3. EUMETSAT

The UK also enhances its EO capabilities through its continued investment in EUMETSAT, having been a Member State since its establishment in 1986. EUMETSAT operates satellites for meteorological data crucial to weather forecasting and climate monitoring. The Met Office represents UK interests in EUMETSAT, supporting research and operational needs.[61] We estimate that UK contributions to EUMETSAT, including mandatory programmes such as Meteosat and the EUMETSAT Polar System,

[52] UK Space Agency (2021e).
[53] CEOI (2025a).
[54] Centre for Strategy & Evaluation Services (2013).
[55] The European Centre for Medium-Range Weather Forecasts (ECMWF) is both a research institute and an operational service that produces global numerical weather predictions and maintains one of the largest meteorological data archives. It operates a world-class supercomputer for forecasting, provides advanced training, and supports the WMO's programmes. As a key player in the EU's Copernicus programme, ECMWF delivers quality-assured climate and atmospheric data while also developing digital twins of the Earth through the Destination Earth initiative.
[56] DSIT & BEIS (2020); Mercator Ocean International is a non-profit organisation transitioning into an intergovernmental entity, providing ocean science-based services for conservation and sustainable use, backed by ten major operational oceanography institutions.
[57] UK in a Changing Europe (2023a).
[58] UK Parliament (2023).
[59] European Commission (2023).
[60] UK in a Changing Europe (2023b).
[61] Met Office (2025).

totalled £59.3m in 2023, compared to £23.4m in 2007. Since 2007, the UK has consistently been among the top contributors to EUMETSAT, averaging as the second or third-largest contributor.[62]

In partnership with CNES, the UK Space Agency delivered the Infrared Atmospheric Sounding Interferometer New Generation (IASI-NG) instrument in 2019, which was successfully launched in August 2025 as part of the MetOp-SG-A series weather satellites, crucial for weather prediction, atmospheric studies and climate research.[63] The EUMETSAT Polar System (EPS) MetOp mission series provides global meteorological and environmental data. In 2024, Airbus Defence and Space UK delivered the Ultraviolet Visible Near-infrared Short-wave Infrared Spectrometer (UVNS) instrument for MetOp-SG-A, thereby enhancing the monitoring of air quality, ozone changes and wildfire emissions.[64]

2.6.4. Bilateral collaboration

Following a bilateral agreement signed in 2014, the UK Space Agency and CNES have collaborated on three significant weather and climate missions: IASI-NG (see above), MicroCarb and SWOT (Surface Water and Ocean Topography). MicroCarb, launched in July 2025, is a joint UK Space Agency and CNES climate mission supported by a £13.9m UK Space Agency investment. The UK is involved in assembling, integrating and testing the satellite, as well as in designing and building key parts, data collection, algorithm development and scientific mission preparation.[65] It will be the first European satellite designed to measure greenhouse gas fluxes on Earth by tracking how much carbon is being absorbed by the oceans and forests, the planet's main 'sinks'.[66]

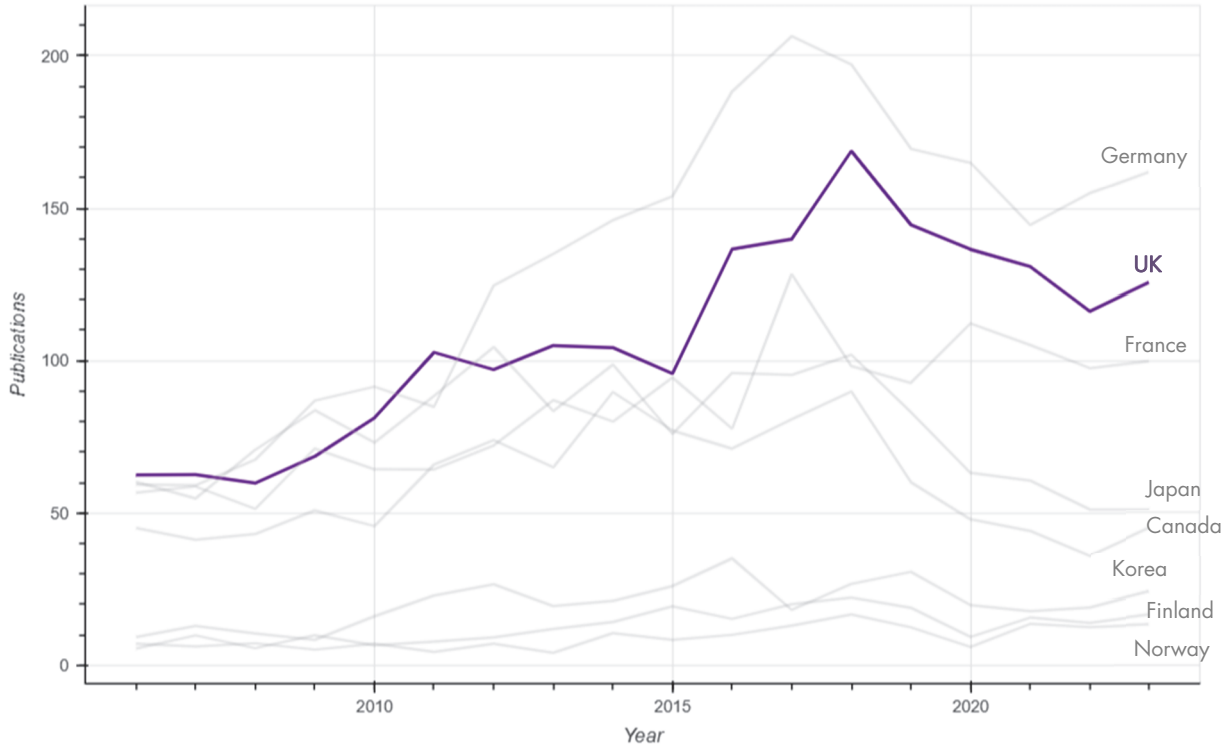
The UK also contributed to the NASA-led SWOT mission, launched in December 2022, which aims to conduct the first global survey of the world's surface waters and oceans. The UK Space Agency provided £12.2m in funding for Honeywell UK[67] to develop and build a duplexer for the mission, a vital component that routes radar signals around the satellite at a power of 1,500W – a level never seen in this kind of device.[68]

2.7. The UK's scientific output – publications

The UK leads among comparator countries in publishing papers in the EO domain, with a steady increase each year (Error! Reference source not found.), only exceeded by Germany. The UK is also a leader in the influence of its EO papers (Error! Reference source not found.), as measured by Field-Weighted Citation Impact (FWCI). These results demonstrate that the UK is a significant player in EO science and has surpassed the publication rates of many comparator countries since the CEOI commenced.

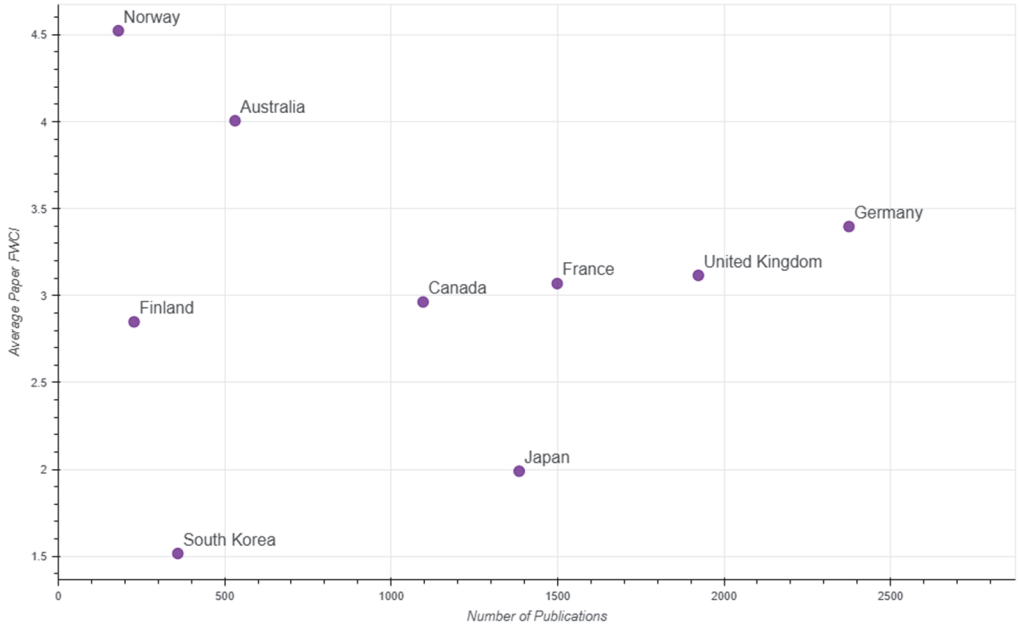
[62] know.space estimates of UK contributions to EUMETSAT, using historical exchange rates (in current prices). See all EUMETSAT resources in References.
[63] CNES (2025).
[64] Airbus (2024).
[65] UK Space Agency (2024d).
[66] Space4Climate (2025).
[67] UK Space Agency (2022b).
[68] UK Space Agency (2019c).

Figure 5: EO-related publications by comparator country



Source: OpenAlex. Publications were plotted by year for each of the comparator countries using fractional counting, where each country was assigned a fractional score for each publication corresponding to its share of the authorships.

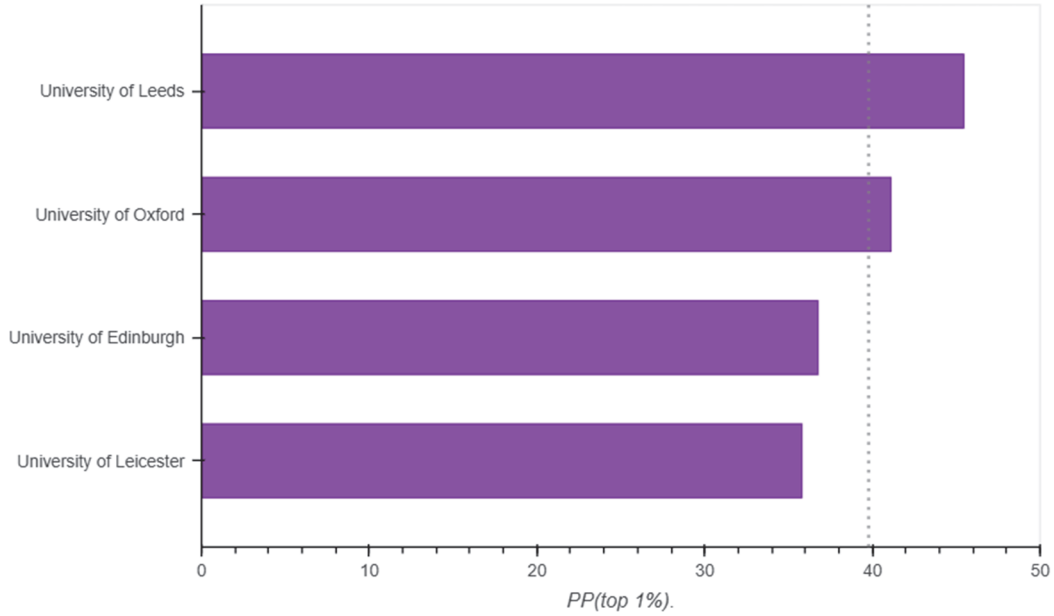
Figure 6: EO-related publications' FWCI by comparator country



Source: OpenAlex. FWCI, as implemented in OpenAlex, groups publications by year of publication and sub-field (e.g. 2020, Geophysics). Then, for each publication, it divides the received citations by the expected citations (the average citations for all publications) within its group. The outcome is a single number for each publication, where '0' indicates that it has received exactly the expected number of citations, values above '0' indicate above-average citations, and values below '0' indicate below-average citations. The average FWCI was calculated for each comparator country, with publication counts for each country obtained using fractional counting.

When we compared the universities with the highest rates that also received CEOI funding (the University of Edinburgh, the University of Leicester, the University of Leeds and the University of Oxford), we found that their production and influence of EO publications also increased over the same time period. We also found that these universities were producing EO papers that perform largely in line with expectations compared to other publications in the same field and year, and belong to the top 1% most frequently cited (**Error! Reference source not found.**). This achievement is partly attributable to these universities' CEOI funding, as well as to the UK's wider support of EO R&D.

Figure 7: Highly-cited EO papers by universities receiving CEOI funding



Source: PP (top 1%) is defined as 'The number and the proportion of a university's publications that, compared with other publications in the same field and in the same year, belong to the top 1% most frequently cited.'[69] This was achieved by using OpenAlex's implementation of citation-normalised percentile and calculating the percentage of each institution's publications in the dataset labelled as being in the top 1% of most frequently cited works.

2.8. Challenges the EO sector faces

Many of the challenges the UK EO sector faces today resemble those faced in 2007 when the CEOI launched. While some are specific to the EO sector, others are more broadly applicable to the space sector and should be considered accordingly. Some of these challenges include:

[69] CWTS (2024).

- **Skills shortages:** A significant skills shortage persists across the UK space industry (see Section 2.4.1). As the demand for EO services and data analytics has grown across industries such as agriculture, defence and climate science, the sector has struggled to recruit skilled professionals to meet these needs. Whilst significant efforts are already underway to address the skills gap, such as the Space Placements in Industry (SPIN) programme and the various Centre for Doctoral Training initiatives, further targeted educational programmes and apprenticeships focused on university courses and vocational training should help to alleviate skills shortages. Increased investment in Science, Technology, Engineering and Mathematics (STEM) education, enhanced cross-sector collaboration and stronger industry-academic partnerships may also help equip future generations with the necessary technical skills.
- **The need for a targeted strategy**: In the wake of the NSS, there is a recognised need within the UK EO sector for a more detailed strategy on EO (and other core capabilities), specifically to strengthen the vision on data acquisition, access and use. Making the case for early-stage technology development is challenging without a clear understanding of its potential end-use case. While there is general support for EO, funding is often spread thinly across multiple initiatives without a clear strategic direction. This situation limits the sector's ability to develop innovative solutions, fully mature and commercialise technologies and scale up operations, hindering the UK's ability to capitalise on EO opportunities fully.
- **Spending uncertainty:** UK EO activities have experienced frequent uncertainty due to changes in government funding allocations, particularly given the Comprehensive Spending Review cycle. These reviews, which determine public sector spending, often result in fluctuating support for EO initiatives. There is a growing recognition within the UK EO sector that providing short-term funding for multiple projects and programmes without guaranteed long-term support could potentially disadvantage the UK compared to other nations.

3. Interim programme impacts

3.1. Summary

The CEOI programme is widely seen as fostering collaboration and enabling both emerging and established organisations to grow in the EO sector. It plays a key role in facilitating access to additional funding and ESA missions while enhancing participants' skills. Interviewees believed that CEOI strengthens the capacity of UK-led initiatives to compete and export, and helps elevate the UK's international EO reputation in the EO sector. The information provided in this section is an updated summary of the section on CEOI project outcomes published in the interim evaluation report.[70]

Box 3: Quick figures on the CEOI interim impact assessment

- Projects funded by the CEOI have seen TRLs increase by an average of 2.2 points, with many grant recipients attributing this progress to the funding.
- 46.2% of respondents reported improvements in skills through CEOI events.
- 73.1% of project participants gained technical insights from CEOI showcases.
- 69.2% reported increased commercialisation ability due to CEOI funding; 96.2% gained reputational benefits.
- CEOI-backed technologies have featured on four launches (2015–2023), with seven more underway, five selected for study and eleven planned for future launches.
- 88.5% of respondents affirmed the CEOI's role in bolstering capacity for international missions; 65.4% acknowledged enhanced export capacity.
- Foreign investment in CEOI projects surpassed that of the UK, with strong support from ESA. Between FY2021/2022 and 2024/2025, projects received £23.4m in foreign public investment – 4.5 times the original total CEOI grant funding over that period.
- Job creation links are unclear, but some anticipate substantial annual revenue from CEOI-funded projects, with one estimate at an additional £10–20m in extra revenue per year.

[70] See Ogden et al. (2024).

3.2. Technology development

Across the projects reviewed, there is an increase in TRL levels attributed to the CEOI programme's funding and support. Survey and monitoring form responses indicate an average increase of 2.2 TRL points from when projects began to the present. The programme and its funding had a particularly substantial impact on technologies in the early stages of development. This finding is especially critical for academic stakeholders, as such projects might otherwise lack the opportunity to advance rapidly. According to the survey responses, projects started at TRL 2.5 on average. As anticipated, projects exhibited considerable variation in TRLs. Some technologies reached levels as high as TRL 9, while others remained at TRL 3 – largely determined by the size and complexity of each project.

Many respondents indicated that their project would have stagnated or not existed without CEOI funding.[71] One project lead reported that their technology stalled after an unsuccessful bid in the 15th call, yet found renewed momentum with a successful bid in the 16th call.[72] Another interviewee suggested alternate funding might have led to slower development compared to CEOI's shorter turnaround grants.[73] It was also noted that the project work might not have been undertaken otherwise, creating a gap in the field and highlighting the CEOI's significant role in advancing EO technology development in the UK.[74]

The CEOI's contributions to TRL progression include sharing knowledge within its extensive network. One project partner suggested that involvement in the CEOI programme indirectly enabled the team to study a larger satellite than they currently fly, providing a case study of the internal design that progressed their own technology.[75] Such second-order effects are common in the portfolio and a product of the CEOI team's longstanding role and dual roles in their own organisations, tapping into their networks to benefit project teams.

The CEOI's focus on low-TRL projects enhances the UK's international competitiveness. Despite limited funding, the CEOI enables basic and advanced research at lower TRLs, where support is most needed due to a funding gap for otherwise high-risk and low-profitability early-stage technologies.[76] As international funding often demands higher TRLs, the CEOI's role at these early stages is crucial. The progression of major projects from CEOI to ESA funding highlights the CEOI's foundational role.[77]

The CEOI's funding of low TRL projects signals key EO technology areas to the government and facilitates the development of technologies in line with those signals. Some government stakeholders perceive the programme as highlighting emerging technologies.[78] However, one UK Defence stakeholder noted that there is limited tracking of CEOI outputs within their organisation.[79] Nonetheless, UK Defence's recent

[71] INT_6B.
[72] INT_7B.
[73] INT_9B.
[74] INT_10B.
[75] INT_13B.
[76] INT_6A.
[77] INT_7A.
[78] INT_3A.
[79] INT_5A.

call for Subject Access Request (SAR) system innovations up to TRLs 4–5[80] aligns with CEOI-supported work, suggesting potential for follow-on funding.

3.3. Collaborations and partnerships

The CEOI is recognised for its collaboration and partnerships, particularly between universities and the private sector. Survey data reveal that industry collaborations often involve a broad network of additional entities. Project leads commend the CEOI's role in uniting academia, industry and government, emphasising the significance of a cohesive space community. Some participants noted unexpected advancements from idea exchanges within this diverse network.[81] The absence of CEOI support might have hindered the formation of these partnerships, potentially excluding participants from future competitions.[82]

The CEOI programme also fortifies existing partnerships, with respondents most likely to enhance ties with universities and industry, and to a lesser extent, public sector stakeholders. Project leads confirmed that CEOI support bolstered pre-existing relationships. The programme's integration of industry and academia is particularly valued, since CEOI support helps de-risk critical technologies and facilitates industry-academia collaborations that might be challenging without financial backing, e.g. by enabling one company to access university facilities through collaboration on a CEOI project.[83]

The CEOI's role in bringing together diverse stakeholders ensures that students gain practical experience within the broader space ecosystem. Leveraging university facilities is seen as a key enabler for innovation and cooperation, with the CEOI's funding strengthening industry-university partnerships.[84] Although these partnerships may not always endure, enhancing industry's understanding of university capabilities is deemed crucial for future projects.[85]

CEOI-facilitated events enhance inter-community connections and sector knowledge-sharing. Workshops that aggregate CEOI-supported projects contribute to sector growth by sharing knowledge, even if they do not directly result in new contracts.[86]

3.4. Skills, jobs and knowledge

Many participants report the CEOI's impact on skills and employment due to its funding and initiatives. Participants widely acknowledged that CEOI involvement helped maintain or enhance their technical skills in developing innovative EO instruments. Some 69.2% of survey respondents reported a significantly increased ability to commercialise research, while 96.2% noted reputational benefits.[87]

The CEOI is instrumental in helping projects secure additional funding, with 88.5% of survey participants finding CEOI support to be effective for international mission competitions. One highlighted a case where an SSTL-conducted CEOI project led to the development of an instrument subsequently flown on

[80] DASA & DSTL (2023).
[81] INT_10B.
[82] INT_1B; INT_5B.
[83] INT_9B.
[84] INT_12B.
[85] INT_10B.
[86] INT_9B.
[87] INT_4B; INT_9B.

CYGNSS, a NASA constellation.[88] Overall, CEOI-backed technologies featured on four launches between 2015 and 2023, with seven more underway, five selected for further study and eleven scheduled for future launches. For instance, the TRUTHS mission, which aims to provide highly accurate climate data, was backed by the CEOI during the proposal stage and chosen from 35 proposals.[89] Several interview participants acknowledged the CEOI's support for bidding on ESA projects, in particular. [90] One project lead commented that they were able to secure further funding from NERC to build on a CEOI-supported project that went on to win an ESA bid, expanding the project further.[91]

Over 46.2% of respondents attributed skill improvement to CEOI events and workshops. Survey data suggested that full attendance was the norm at CEOI annual conferences, with many participants finding them valuable for developing skills and knowledge. Additionally, 73.1% attended technology showcases.

The CEOI programme enables knowledge sharing, with 38.5% of respondents noting increased exchange between academic and industrial EO communities. While measuring knowledge acquisition is inherently complex, interviews revealed a growing knowledge base among participants, facilitated by project collaboration and broader engagement within the CEOI network. This growth has deepened technical understanding and expanded awareness of advancements in the EO sector. For example, one project lead noted that the CEOI's involvement enhanced their understanding of novel defence technologies, opening new opportunities in the defence sector.[92]

3.5. International impact

Policy roundtable participants agreed that the UK has a strong heritage in the EO sector, with experience across academia and industry in highly specialised instrumentation.[93] Legacy datasets generated from sensors constructed with UK expertise still have the potential for new applications, highlighting the durability of the UK Space Agency's historical EO investments, including the CEOI.[94]

The CEOI's strategy to support predominantly early-stage EO R&D was considered key in maintaining the UK's EO capabilities. However, it yielded few clear examples of new UK-led missions derived from that funding. The exception is TRUTHS, for which the CEOI's calibration and coordination expertise was instrumental in it becoming a UK-led ESA mission, providing the technical expertise and rigour necessary to progress in the ESA landscape.[95] A related threat is the impact of the UK's withdrawal from the European Union on the UK's ability to collaborate with EU and ESA entities. Participants emphasised the need to maintain and rebuild relationships to take advantage of internationally collaborative EO programmes into which projects supported by CEOI can expand their R&D.[96]

A potential example of the issues caused by the UK's brief period outside of Copernicus is from 2020, following ESA's announcement of contractors developing the next generation of Sentinel spacecraft. All

[88] SSTL (2016).
[89] WECD (2022).
[90] INT_6B; INT_8B.
[91] INT_8B.
[92] INT_4B.
[93] Findings from Roundtable 1: the state of UK EO, with wider stakeholders / CEOI-adjacent stakeholders.
[94] Findings from Roundtable 1: the state of UK EO, with wider stakeholders / CEOI-adjacent stakeholders.
[95] Findings from Roundtable 2: CEOI adjacent.
[96] Findings from Roundtable 2: CEOI adjacent.

six missions' primary contracts have been awarded to continental bids, despite UK efforts, resulting in roughly 30% less UK-based sub-contracted work than expected.[97] The Copernicus Expansion is targeting a slate of six missions, including the Copernicus Hyperspectral Imaging Mission (CHIME), the Copernicus Polar Ice and Snow Topography Altimeter (CRISTAL) and the Copernicus Anthropogenic Carbon Dioxide Monitoring (CO2M) mission, none of which the UK holds a primary contract for.[98]

The CEOI programme is key in enhancing UK companies' competitiveness for international funding, with 88.5% of respondents affirming its role in bolstering their capacity to lead or partake in international missions. Half of the respondents acknowledged a substantial increase in their competitiveness as a result of CEOI funding. The programme fulfils a need in the UK space sector by fostering industry-academic collaboration, thereby enhancing the UK's standing in comparison to European entities within the ESA. Notably, the CEOI's support has been instrumental in securing ESA bids and gaining visibility amongst member states and the Data Operations Scientific and Technical Advisory Group (DOSTAG)[99] – as evidenced by a project lead who leveraged CEOI support to obtain NERC funding, subsequently winning an ESA bid.[100]

Several projects with an export focus lauded the CEOI's early-stage support in technology development and EO service provision. Approximately 65.4% of survey respondents acknowledged that the CEOI programme enhanced their capacity to export products and services, and nearly one-third emphasised that the CEOI significantly enabled exports. One project lead noted that up to 98% of their services are now exported from the UK, facilitated by the CEOI's initial funding.[101] Another respondent mentioned that although their project did not benefit from the UK network facilitated by the CEOI due to its focus on export markets, they did gain valuable data that was exported to international clients.[102]

Some participants believed that the CEOI's impact was limited by insufficient funding and inadequate governmental support in international markets. One project lead refrained from bidding on another CEOI round due to limited opportunities in the UK market, opting instead for alternative funding to access international markets.[103] Although beyond the CEOI's remit, the UK Space Agency might consider providing post-project support to help projects access larger international funding pools, alongside UK programmes like the National Space Innovation Programme and the Unlocking Space for Business programme.

Stakeholders acknowledged the CEOI's role in bolstering the UK's international reputation. Despite lower UK public R&D investment in EO compared to Germany and France, the UK has made significant scientific contributions, with the CEOI as a key driver.[104] The survey revealed that 57.7% of respondents felt that CEOI-funded projects promoted UK EO capabilities. Thus, the programme's coordination is valued, enhancing the UK's credibility as a space entity. One stakeholder suggested that without the CEOI, the UK would be a 'platform' rather than a 'satellite and sensor' nation, diminishing its international

[97] Amos (2020).
[98] Amos (2020).
[99] INT_10B; INT_6B; INT_8B.
[100] INT_8B.
[101] INT_4B.
[102] INT_1B.
[103] INT_4B.
[104] INT_3A; INT_6A; INT_7A; INT_1A.

leadership. One CEOI-funded project achieved success with NASA, illustrating the CEOI's 'soft influence' in spurring international innovation.[105] However, one partner noted that international awareness is limited by the focus on mission launches over initial R&D, which affects the CEOI's international reputation, although its primary aim is to enable post-project successes.[106]

3.6. North Star Metric outcomes

This evaluation encountered notable reporting gaps in North Star Metric data collection among project participants. The North Star Metric is designed to evaluate the investment and revenue stimulated by the UK Space Agency within the UK space sector, serving as the principal measure of its success. The key elements of the North Star Metric include match funding, private investment, internal investment and revenue. Despite the requirement for projects to report on the North Star Metric in grant funding agreements since 2022, the research team encountered reporting gaps that necessitate attention from the UK Space Agency and the CEOI to enhance ongoing monitoring activities.

Since Round 6, the CEOI has allocated over £31.8m to projects, and partners have contributed £10.6m.[107] In addition to match funding, several of the reviewed projects allocated internal investment to progress the technologies. In general, this internal funding was highest among private companies than universities, some of whom were only able to allocate limited resources, and only where necessary, e.g. to enable a demonstration. The amounts of internal funding varied from a few tens of thousands for small projects to £3m of funding by a company over two years to progress their CEOI-funded Flagship project.

Based on available data, foreign public investment across reviewed projects exceeded UK public investment, indicating strong international interest, as well as TRL progression among CEOI-funded projects. For 2021/2022, reviewed projects secured £2m from foreign public funding, compared to £0.8m from UK public funding, with this gap increasing year on year (2022/2023: £2.8m foreign public vs £0.1m UK public; 2023/2024: £6.7m foreign public vs £1m UK public; 2024/2025: £11.9m foreign public vs £3.4m UK public). Most of the international public funding came from ESA, reflecting the progression of CEOI-funded projects to eventually supporting international missions.

Most of the recent CEOI projects we surveyed are in the pre-revenues stage, with technologies still under development. As such, there are few examples of realised revenues to date, but some organisations were buoyant in their future revenue expectations. Notably, one organisation anticipates selling 1–2 satellites or payloads annually from Year 2 to 5, generating £10–20m in revenue per year, which is a significant portion of the total £65m annual revenue. However, the wider benefits of their technology are difficult to quantify, as customers may gain more financially from the services enabled by the technology than from the contract value, and the CEOI-funded product is just one component of a complex spacecraft system.

Most project teams noted that jobs were protected by CEOI funding, although few project participants could link CEOI funding directly to job creation. While recruitment increased around the project start in a few cases, it was only directly attributed to CEOI funding in a minority of cases, and not linked to organisational growth more broadly – although this may suggest that CEOI funding had a more indirect

[105] INT_2A.
[106] INT_6B; INT_13B.
[107] There are missing match funding figures for 9 of 118 projects recorded from the 6th call onwards.

impact on funding recipients' ability to plan ahead and achieve growth, including through involvement in major missions.

4. Economic evaluation

4.1. Summary

This economic evaluation optimises limited data on the CEOI's economic outcomes, focusing on 39 projects with cost-benefit data. We assess CEOI Calls 11–16 (2018–2025) and smaller calls due to earlier data gaps. Despite these limitations, **we estimate the real discounted (Present Value (PV), 2024/2025) and attribution-adjusted UK benefit of CEOI Calls 11–16 at £30.2m,** driven by three large ESA contracts with a combined value of over £20m.

Box 4: Quick figures on the CEOI economic evaluation

- The real discounted and attribution-adjusted UK benefit of the CEOI (Calls 11–16) is at least £30.2m to date, excluding expectations.
- Foreign Direct Investment (FDI) stands at £28.9m in UK benefits (73% of total benefits).
- Internal investment contributes £4.1m (14%) to total UK benefits, and UK private external investment contributes a further £3.1m (9%). The economic value associated with Gross Value Added (GVA), job creation and publications is low, likely reflecting the early stage of this evaluation.
- The total nominal economic cost of CEOI Calls 11–16 and smaller projects over this period (roughly between 2018 and 2025) will be £20.8m, of which £14.9m comes from grant funding and £5.8m from matched funding.

4.2. Introduction

While the rest of this report has covered the CEOI since its inception, this economic evaluation focuses on Calls 11–16 of the CEOI, covering the period roughly between 2018 and 2025, due to earlier data limitations.[108] Since economic data (e.g. investment, revenues and job creation) have not been routinely captured for funded projects, there is a trade-off between recent projects with complete data and older projects with developed impacts. We focus on newer projects (Calls 11–16) but include a case study of CEOI funding to the University of Leeds over a decade ago to illustrate the long timelines required for substantial impact.

Although our economic analysis focuses on the benefits to funded organisations, we expect that future benefits will extend to wider society, particularly in understanding climate change. Any quantitative

[108] In our analysis, we cover CEOI Calls 11–16, along with any smaller ad hoc calls during the same period. These include EE11 and EE12 (Earth Explorer) Mission Proposal Development Support projects, TRL Raising and Facility Enhancement Fast Tracks, Special Projects, Strategic Projects and 2024 Small Projects. Overall, our analysis covers a total of 76 CEOI projects.

estimates likely underestimate the ultimate benefit of CEOI funding, especially at this early stage. This challenge is common to public R&D funding, not just CEOI or space R&D funding. Some significant benefits of CEOI funding are challenging to monetise, such as knowledge, scientific progress and facilitated collaborations. Thus, our quantitative estimates should be considered as a lower bound on the economic benefit to date.

4.3. Approach to economic evaluation

Our economic evaluation aims to capture benefits from funding holistically, acknowledging that the benefits realisation journey is ongoing and the impacts data, particularly on monetisable outcomes, are sometimes incomplete. Given this, we limited our central economic evaluation to the 39 projects for which we have data on both costs and benefits. For more details, see the Evaluation Plan.[109]

At a high level, we compare the costs of delivering each programme against the benefits delivered so far. Costs include grant funding (the public cost) and matched funding contributions (the private cost). The benefits we quantify include leveraged external investment,[110] internal investment, Gross Value Added (GVA) and the value of job creation. Evidence on these impacts comes from two surveys of funded organisations, supplemented by targeted interviews and desk-based research.

Cost data was provided by the CEOI at the project level, outlining the grant funding allocated to each project, the associated matched funding contribution, and the project's start and end dates. We assumed that costs were spread evenly across project durations to estimate total costs by financial year.

We asked organisations to provide the amount and sources of external investment received to date, as well as expectations for external investment over the next five years (forecasts not included in our central analysis). We also asked for estimates of internal investment to date.

We estimate GVA using a space-industry-specific revenue-to-GVA ratio of 2.6.[111] We leverage revenue estimates provided by funded organisations, including realised revenues and expected revenues over the next five years (forecasts not included in our central analysis).

We estimated the value of job creation using a wage premia approach,[112] which assumes that, in the absence of CEOI funding, those in roles created through funding would instead be working in similar roles outside the sector and earning different salaries.[113] A wage premia approach supposes that the economic value of job creation lies in creating new, better-paid roles rather than new jobs per se. We directly sourced job

[109] The evaluation plan is available from Khelifi et al (2024)

[110] Throughout our analysis, we treat external and internal investment as benefits to society, reflecting the positive role of investment in creating a pipeline for future economic benefit and the central role of investment in the UK Space Agency's North Star Metric. However, we note that DSIT appraisal advice focuses on quantifying the benefits that stem from investment, which are likely to accrue over the longer term. UK external and internal investment is therefore counted as a cost by DSIT, reflecting the opportunity cost of investment. Foreign investment is not factored into the cost-benefit analysis. This methodology will capture the long-term benefits of investment. However, for the CEOI, it is too early to meaningfully calculate the net present social value (NPSV) using this approach. We include private external investment and foreign public external investment (including ESA funding) in our totals.

[111] These are sourced from UK Space Agency's underlying economic model (UK Space Agency, 2022).

[112] See know.space (2023).

[113] Using contextual information, job creation is divided into sub-categories of role type and seniority. The wage premia associated with each job type is then taken from know.space (2023). Estimates of wage premia are adjusted to current prices. For a fuller description of the methodology employed, see know.space (2023).

creation data from funded organisations, and took wage premia estimates from a recent study of wage premia in the space sector.[114]

We also estimate the economic value of research publications, using an EO-specific estimate of the benefit of such publications,[115] adjusted for the year of publication (£19,000 per paper). The methodology underpinning this estimate assumes that the social benefit of such publications will be at least as much as the private cost of writing (and publishing) an article. This methodology is conservative and generates a lower-bound estimate on the value of publications. Data on publications were provided directly by project teams.

Our economic evaluation encompasses 76 CEOI projects, spanning Call 11 to the most recent Call 16, aligned with the 2017/2018 to 2024/2025 period. Although our central analysis focused on benefits over this period, we also provided alternative numbers considering expectations for the 2025/2026 to 2029/2030 period. We asked project teams to provide expectations of external investment and income over the next five years. Although these indicate the expected medium-term benefits from CEOI funding, they still provide only a partial picture of potential future benefits, given the reporting gaps and limited time horizon. These estimates are also subject to significant uncertainty.

4.3.1. Caveats to economic evaluation

Below, we set out the key caveats specific to our economic evaluation:

- **Data gaps:** Our findings are based on 34 survey responses, multiple interviews and an earlier survey with 26 responses, covering 39 of the 76 projects in scope (51%). Since data gaps only affect the benefits side, our central analysis estimated value for money based on projects with available impact data, thereby avoiding artificially low returns by excluding projects without benefit evidence. This approach might have overestimated benefits due to selection bias, as successful projects may have been more likely to respond to our survey. To address this, we provide alternative estimates that include all projects, assuming zero benefits from non-respondents; these likely underestimate the CEOI's value for money.[116] We also provide estimates that assume these non-respondents generated half the total benefits of respondent organisations.
- **Non-monetisable benefits:** Some significant benefits of CEOI funding are challenging to monetise, such as knowledge, scientific progress and facilitated collaborations. Thus, our quantitative estimates should be considered as a lower bound on the economic benefit to date.
- **Long timelines to impact**: Due to earlier data limitations, this evaluation only covers CEOI Calls 11–16, which roughly span the period from 2018 to 2025. Since we expect many of the key benefits to be realised with a substantial lag, our estimates underestimate the eventual expected benefits arising from funded projects.

[114] See know.space (2023)..

[115] Morretta et al. (2022) estimate that the average value of researcher and publisher activity in 2018 was between €4,500 and €22,000. We calculated the average of these two values, converted it to GBP, and then adjusted for inflation to arrive at £19,000 per publication.

[116] We have not extrapolated the impacts for projects on which we have impact data to all funded projects. This is because there was likely to be selection bias among respondents, i.e. those whose projects have had the most favourable impacts were more likely to respond to our requests.

- **Attribution of benefits**: This is a key challenge in any economic evaluation, with impacts stemming from multiple inputs that interact in complex ways. For example, CEOI projects often received funding from other sources, and many projects funded through Call 11 onwards had received earlier funding through the CEOI, which is outside the scope of our present analysis. This makes attribution particularly complex, with the most recent studies building on possibly years of prior research. Broadly, our approach has been to ask project teams directly for benefits which are linked to their CEOI projects, for example, 'How much revenue has your organisation generated that can be attributed to CEOI?" We have also applied an attribution share (see below).

4.3.2. Key assumptions

Our analysis necessarily relied on several assumptions:

- **Discounting:** We discounted future benefits using the standard 3.5% discount rate recommended by the Green Book. We present all totals in discounted Present Value (PV) terms (2024/2025).
- **Inflation-adjustment:** We adjusted all costs and benefits to constant prices (2024/2025).
- **Optimism bias adjustment:** We made a 50% optimism bias adjustment[117] to forecasted estimates to address the demonstrated systematic tendency for individuals to overestimate future benefits.
- **Attribution shares:** Where impacts were clearly the result of multiple inputs, we assigned attribution shares on a case-by-case basis. We discuss the extent to which benefits are attributable below, leveraging insights from our assessment of programme impacts.
- **Leakage:** We removed non-UK benefits to account for leakage, i.e. the extent to which benefits accrued outside the UK, such as non-UK jobs and external investment into non-UK arms of funded organisations.[118]
- **Additionality:** We applied a 90% additionality assumption to all benefits to account for deadweight, i.e. a small proportion of economic activity generated would likely have occurred without CEOI funding.

4.4. The economic benefits of the CEOI

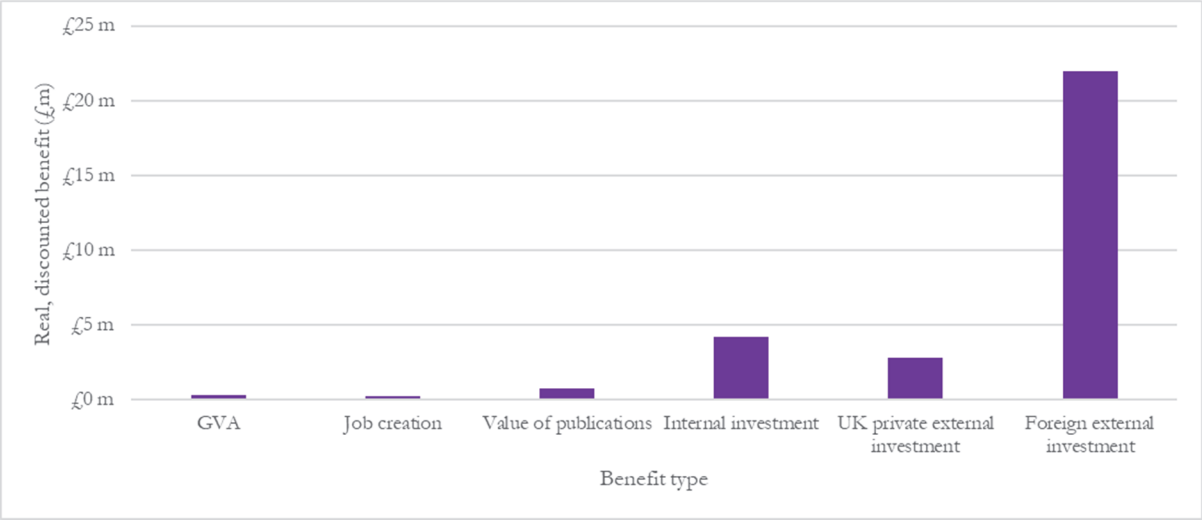
We estimate the real discounted and attribution-adjusted UK benefit of the CEOI (Calls 11–16) to be at least £30.2m to date, excluding expectations. This total is driven by foreign external investment, i.e. foreign investment into the UK, which accounts for £28.9m in UK benefit (73% of total benefits). ESA contracts are the most common source of foreign investment. Notable investment events driving this trend include two ESA contracts to Craft Prospect, worth £6.1m and £7m respectively, and a £7m ESA contract to RAL Space.[119] This finding is in line with the objective of the most recent CEOI Business Case to *'Prepare*

[117] Note that 50% is necessarily a somewhat arbitrary number without concrete evidence on the extent to which optimism bias is prevalent. We chose 50% to reflect HM Treasury (2013): *Supplementary Green Book Guidance: Optimism Bias*.
[118] Due to limited information provided in survey responses, we were not always able to verify that economic activity occurred in the UK.
[119] Due to the limited detail provided in survey responses, we were unable to independently verify these contracts. We have assumed 100% attribution, as survey questions were framed to capture only those benefits attributable to the CEOI.

the UK EO community to win global market opportunities, including those resulting from CMin22'.[120] Still, overall benefits are driven by a few significant events and are therefore sensitive to their inclusion.

Beyond foreign external investment, internal investment contributes £4.1m (14%) to total UK benefits and UK private external investment a further £3.1m (9%). The economic value associated with GVA, job creation and publications is currently low relative to investment impacts, with these benefits totalling just £1.3m. We view this as a reflection of the relatively early stage of projects. Most projects are still at the pre-revenue stage or are generating modest early revenues, which means GVA to date is low. At this stage, most of the CEOI's employment benefits are concentrated in existing jobs supported through CEOI funding, rather than in wholly new positions being created. This is also a reflection of the early stage of impact generation. As projects progress towards commercialisation, we would expect greater job creation associated with more economic activity within funded organisations. Lastly, the low value of publications to date reflects the relatively low publication numbers from these recent projects, linked to long publication timelines and our conservative approach to modelling their economic value.

Figure 8: Real discounted benefits, *excluding* expectations, 2017/2018 to 2024/2025



Source: Interviews and surveys of CEOI project leads. know.space analysis.

Most reported benefits have accrued in the last two years, with a significant jump in 2021/2022. This partly reflects the long timelines to impact, but also largely demonstrates the bias in our sample towards more recent projects, which were more likely to respond to our survey. Of the 39 projects for which we have some impact data, 20 finished in 2024/2025. For every other year of project completion, we have 2–4 data points.

Table 4: Real discounted benefits by year, *excluding* expectations, from 2017 to 2025

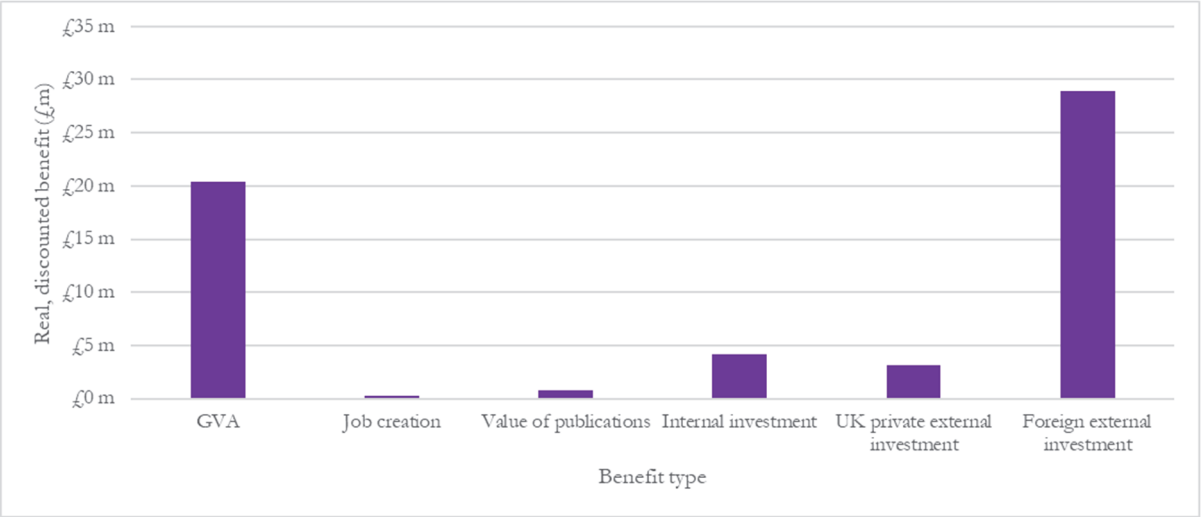
	17/18	18/19	19/20	20/21	21/22	22/23	24/25
Total real discounted UK benefits	£0.1m	£0.1m	£0.1m	£2.2m	£3.9m	£10m	£13.9m

Source: Interviews and surveys of CEOI project leads. know.space analysis.

[120] ESA (2022).

Given we are assessing impact at an early stage, we expect the most significant benefits to accrue in the future. Many project teams are targeting upcoming ESA-led missions and pointing to substantial future ESA funding they could potentially capture. Reflecting this, we also estimate monetisable benefit over the 2025/2026 to 2029/2030 period, including expectations in our totals.[121] Provided by funded organisations, these forward-looking estimates should be considered indicative only, given the potential for optimism bias and gaps in our data. Notwithstanding these caveats, the real discounted and attribution-adjusted UK benefits of the CEOI (Calls 11-16), including expectations, total at least £57.6m.

Figure 9: Real discounted benefit, *including* expectations



Source: Interviews and surveys of CEOI project leads. know.space analysis.

When we include expectations, external foreign investment remains the most significant component of total benefits, accounting for 50% of all benefits. However, expected revenues are also sizeable, with expected GVA accounting for £20.4m in expected benefits (35%). Revenue, and therefore GVA, forecasts are driven by a small subset of projects' expectations of future revenue. SSTL forecasts buoyant revenues of between £10–20m per annum over the next five years, as they expect to sell one to two satellites or payloads per year. If we exclude just these SSTL revenues, total benefits fall to £46.6m. Space Flow also projects notable revenues of £30m from their Glamis project across consortium members. Whilst it is normal that the most significant impacts of R&D funding concentrate in just a few projects, this increases the risk that the programme's overall benefits could be far lower than expected if one or two projects do not deliver their expected benefits. We note that many organisations chose not to provide forecasts of any future revenue or investment.

Overall, our evidence suggests that the near-term benefits of CEOI funding are concentrated in external investment, with internal investment also being significant. Over the medium term, we expect GVA to form a more substantial component of the overall benefits as technologies developed through the CEOI are commercialised, generating revenues. Further ahead, we might expect spillover benefits to form a significant proportion of the overall benefits as consumers and society more broadly benefit from technologies

[121] We asked project teams to estimate future investments and revenues as part of our recent survey and applied a 50% optimism bias (see Section 4.3.2, 'Key assumptions').

developed, e.g. through improved climate monitoring. Our case study (see below) provides an example of a timeline of benefits realisation for a CEOI-funded project.

4.4.1. Attribution of benefits

We have adjusted all presented results for attribution. The appropriate level of attribution is considered for individual benefits, and our totals are also subject to a 90% additionality assumption to account for deadweight, as our survey results suggested that a small minority of projects may have proceeded similarly without CEOI funding. Our assumptions about the extent to which benefits are attributable to the CEOI are crucial to determining total monetisable benefits. In particular, given the extent to which a few significant foreign external investment events, notably ESA contracts, drive overall benefits, results are sensitive to our assumptions about the extent to which these external investments are attributable to the CEOI. Suppose we apply a further 50% attribution adjustment to the three large ESA investments generated by Craft Prospect and RAL Space, for example. In that case, the total real discounted realised benefits fall from £30.2m to £23.6m.

Evidence from funded organisations suggests that crowding-out associated with the CEOI is low. Crowding out is a phenomenon whereby increased government spending leads to a reduction in private investment. In our earlier survey, 88% of respondents reported that they did not consider any other funding programme when applying to the CEOI and those who did look elsewhere only considered public funding sources. One project lead noted that the 'CEOI seems unique in funding projects at the tricky TRL levels of 2–4.' Another team noted, 'We are a university… relying on sources such as [the UK Space Agency] and CEOI for this type of development.' Given the low TRL of supported technologies, private investors were unlikely to fund technology development without prior de-risking from the government.[122]

We also considered displacement (i.e. the extent to which economic activity generated by CEOI displaces other activity in the economy). For revenues, external and internal investment, we assumed zero displacement, as the UK is presumed to be capturing a share of emerging global markets that bring new economic activity to the UK. For job creation, our DSIT-recommended wage premia methodology implicitly assumed 100% displacement, i.e. everyone in a job created as a result of CEOI funding would otherwise be working in a similar job outside the space sector. We believe this is a reasonable assumption, given that the economy was operating near full employment for much of the analysis period.

We also designed our approach to account for leakage (outflows of funds from the UK). We deliberately asked project teams for UK-specific benefits (e.g. 'Were any UK-based jobs created as a result of CEOI funding?') and researched individual investment events to ensure funds were going into UK-based companies.

Lastly, we believe that the deadweight associated with the CEOI is likely to be low, as most projects did not proceed at the planned scale in the absence of funding. Some 54% of project teams reported that they could not have undertaken their project at all without CEOI funding, and 35% stated that they could not have undertaken their projects at the same scale. Only 12% of project teams believed they could have carried out

[122] This finding has been demonstrated elsewhere in the space industry. See European Space Policy Institute (2024).

their projects at the same scale without CEOI funding. To reflect the small minority of projects that could have gone ahead without CEOI funding, we applied a 90% additionality adjustment to our totals.

4.4.2. Non-monetisable benefits

The evidence suggests that the non-monetisable benefits from the CEOI are significant and should be central to any evaluation of the extent to which the CEOI is delivering value for money. As detailed in the impact assessment, there are key benefits of the CEOI that we cannot monetise. Notably, the programme has facilitated an average TRL progression of 2.2 points, bolstered the UK's international standing in EO and facilitated valuable collaboration across industry and academia. Moreover, the most significant benefits of funding will likely be realised once the technologies are commercialised or otherwise operationalised, thereby facilitating benefits to end-users and wider society. Notably, with several projects developing technologies intended to improve climate monitoring, a key societal benefit could lie in marginal improvements in the global response to climate change through a deeper understanding of how our planet is changing. Improved EO solutions will also likely generate efficiency savings in various downstream markets, including agriculture, mining and maritime activities. For these reasons, we must consider the value for money the CEOI offers holistically, looking beyond monetised estimates of benefit.

4.5. The economic cost of the CEOI

Overall, for economic modelling and using simplifying assumptions rather than an accurate breakdown of spending,[123] we estimate the total nominal economic cost of CEOI Calls 11–16 and smaller projects over the same approximate period (2018–2025) at £20.8m, of which £14.9m comes from grant funding and £5.8m comes from matched funding.

In our central value-for-money analysis, we focus on the subset of these projects for which we have some impact data. We estimate that the total nominal economic cost of the 39 projects for which we have some impact data will be £10.9m, of which £7.9m comes from grant funding and £3.0m from matched funding. In real discounted terms, the cost of these projects is £12.2m, of which £8.9m is grant funding.[124]

The full economic cost of these CEOI projects extends beyond total project costs. As the technologies developed through the CEOI continue evolving, additional private costs will accrue.

4.6. Value for money

It is too early to assess the total economic impact of these projects. Nonetheless, there are positive signs indicating potential future benefits. Notably, further investments catalysed by the CEOI are creating a pipeline for future benefits, concentrated in a few key projects. Additionally, we have not been able to quantify significant benefits**;** our estimates should be treated as lower bounds on potential benefits due to the likelihood of large, as yet unforeseen, future benefits and the importance of non-monetisable benefits

[123] As noted above, in the absence of data on CEOI funding and matched funding contributions by financial year, we assume costs are spread evenly over the duration of funded projects.

[124] These are the cost totals we use in our central analysis.

in driving overall impact. Future evaluations will be crucial for tracking these developing benefits and providing more robust conclusions on the overall value for money.

4.6.1. Comparison with anticipated returns

A meaningful comparison of our results with anticipated returns is limited by differences in methodology and the dominance of a few large economic impacts. The 2022 CEOI Business Case projected an anticipated return on investment (RoI) of £3 for every £1 invested over the 2016–2021 period, leveraging the results of a previous (unpublished) CEOI evaluation. We do not estimate RoI. While the previous evaluation considered leveraged UK public funding as a benefit (which we do not), we consider a broader range of benefits (internal investment, jobs, revenue and publications) and adjust for additionality and inflation.

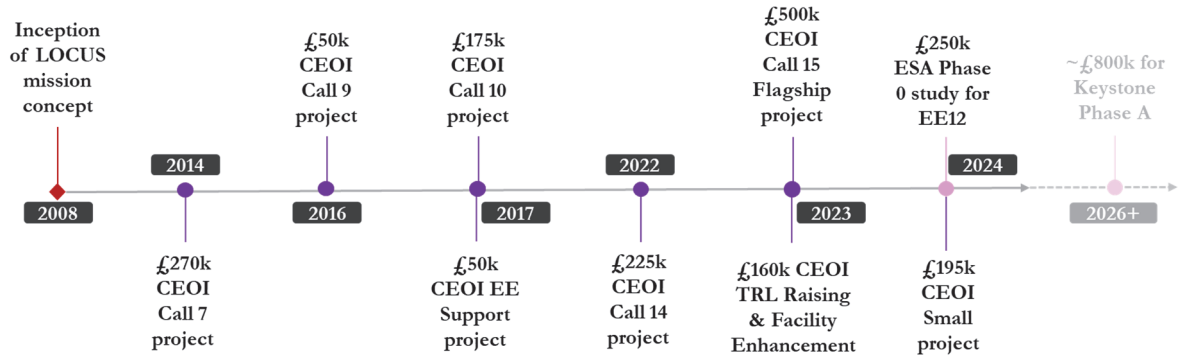
A £14m ESA investment (RAL Space's ESA Scout mission) and a £15m private investment into SatVu drive the previous evaluation's results, demonstrating that, like our findings, their estimates are sensitive to a few significant investment events. The previous evaluation did not adjust these impacts for additionality or attribution. If we removed these two investments for illustrative purposes, the RoI falls from 3 to 1. Whilst we cannot meaningfully compare the previously estimated RoI with our own due to differences in approach, it is clear that significant investment events concentrated in a few projects drive the overall value for money associated with the programme. This result is not unexpected for an R&D programme, especially a low-TRL programme, where we cannot expect all projects to succeed.

4.7. Case study: The University of Leeds

Our economic evaluation has focused primarily on the most recent CEOI projects from Call 11 onwards, noting that these projects are relatively early in their benefits realisation journeys, and on monetisable benefits. The following case study of the funding the University of Leeds received for terahertz (THz) quantum-cascade laser development demonstrates the potentially significant benefits that can arise from funding longer timelines than those covered in our primary economic analysis.

The University of Leeds and its partners at RAL Space have led eight CEOI projects, with a combined value of £2m. Over a decade later, the project team are on the cusp of potentially winning a large ESA contract for their Keystone mission. The idea for the Linking Observations of Climate, the Upper-Atmosphere and Space-Weather (LOCUS) ESA mission was first conceived in 2008 to fill a gap in capabilities for observing gases in the THz frequency range. The CEOI was chosen as a route for developing the technology to a point where the team could bring it to ESA as a potential mission, with the first CEOI technology funding received in 2014. CEOI funding enabled the University of Leeds and its partners to develop their capabilities in THz receivers over a period of more than a decade. Today, the THz lab at Leeds supports 20–25 researchers, with at least six to seven employees or postgraduate researchers working on a project originating from CEOI funding at any one time.

Figure 10: Funding timeline for the University of Leeds' LOCUS concept



Note: funding amounts for Keystone Phase A and the next ESA EE12 mission are uncertain at the time of writing.

With CEOI support, LOCUS developed into a new mission concept, Keystone, to be delivered by a consortium comprising the University of Leeds, RAL Space, TK Instruments and University of Bern. ESA is funding a £250k Phase 0 study for Earth Explorer 12 (EE12) to develop a calibration system for THz receivers.[125] Although the current ESA contract is relatively small, Keystone is one of four potential candidates for ESA's EE12 mission. If selected in 2026, the contract for EE12 could be worth approximately £800,000 to the consortium; however, the most significant potential benefits will likely affect wider society through improved climate monitoring. If selected, Keystone would provide the first direct observations of atomic oxygen in the altitude range of 50–150 km, enabling scientists to understand better the processes driving variability in the atmosphere's mesosphere-lower-thermosphere region. This understanding could inform models of the thermosphere, thereby enhancing the accuracy of climate change monitoring and facilitating better policymaking and supporting efforts to combat the climate crisis. This technology could also facilitate the earlier detection of space weather events through an enhanced ability to detect certain atmospheric gases. Early detection of these events can mitigate the worst impacts of space weather. These impacts are challenging to monetise, particularly at this early stage, but should be considered key benefits of CEOI funding.

Lastly, this technology has potential commercial applications in communications, as THz waves can be used in quantum key distribution, facilitating secure communications. Although this application has been demonstrated in the lab, it is at least five years away from commercialisation. Nonetheless, it could ultimately offer a further revenue stream from this technology, as well as better communication for end users.

[125] This case study leverages insights from an interview with the University of Leeds.

CEOI funding is yielding potentially substantial economic and societal benefits more than a decade after funding was first received. Whilst monetisable benefits to the consortium will likely be substantial, the most significant benefits are likely to be social impacts, which are intrinsically difficult to monetise. Although value-for-money analysis provides a vital tool for assessing the extent to which funding has been effective, it cannot capture the full benefits of funding.

Case study: The University of Leeds:

- >£2m in CEOI investment to date (incl. matched funding contributions) across eight projects led by the University of Leeds and RAL Space.
- Development of leading UK capabilities in observing gases in the THz frequency range, including six to seven highly skilled roles supported at any one time.
- £250k ESA Phase 0 study for Earth Explorer 12 (EE12) won, with the potential for a ~£800k contract if chosen for EE12.
- Substantial societal benefit expected if chosen for EE12: improved climate monitoring, earlier detection of space weather events and more secure communications.

The true value of CEOI projects will be realised over the long term, potentially years or decades after initial funding. Projects often require years of research before technologies can be effectively incorporated into missions, followed by additional years before the benefits to end users are realised. As with any R&D programme, not all CEOI-developed technologies will be successfully utilised; the benefits will likely be concentrated in a few projects that were highly successful in developing and operationalising their technologies. At this relatively early stage, impacts concentrate in projects that have leveraged CEOI work for further investment and contracts, particularly ESA missions. These long timelines mean that only the early signs of future potential are measurable now. Ongoing monitoring is essential to capture emerging benefits for a comprehensive future assessment of value for money.

5. Process evaluation

5.1. Summary

The headline conclusion from the process evaluation is that the CEOI's model and processes are broadly working well for grant holders. Consultees praised the technical expertise and support that the CEOI gave at each stage of their applications and projects, citing it as the key added value of the CEOI model. The current third-party consortium model is considered optimal for the CEOI going forward, as it retains those benefits. However, the one-year funding cycles limit projects' and the CEOI's abilities to achieve technical and scientific outcomes, and to support even more high-quality applications. Ensuring more uniform and comprehensive data collection will also help to evidence the CEOI's success for future spending reviews.

Box 5: Process evaluation – key points

- The CEOI third-party consortium is designed to promote impartiality, preventing conflicts of interest and IP disputes.
- Outsourcing remains the preferred model for the UK Space Agency and the CEOI. The UK Space Agency would not be able to internally replicate the CEOI's expertise, experience or heritage in EO to provide the same benefits to grant holders without significant investments in technical expertise.
- The CEOI's current FY funding constraints limit their potential impact.
- Adopting a multi-year funding model could improve the CEOI and project outcomes.
- There is scope for improving current M&E practices and guidelines to ensure that the required data is recorded, maintained and transferred to evaluators.

5.2. The CEOI model

Before assessing the processes of the CEOI model, we first conducted interviews with the CEOI and the UK Space Agency to understand how the model works, why it was chosen and its general characteristics. We present this briefly before discussing the results of the wider process evaluation.

Generally, competitive public funding for R&D projects is awarded, overseen and administered by a government department or body, such as UKRI councils or agencies like the UK Space Agency, to ensure sufficient oversight of the spend, transparency and fairness in the selection processes. Non-governmental institutions and consortia may be contracted to distribute, manage or monitor such funding in cases where there is no capacity and/or capability to do so within the government. The CEOI fits into this latter model. A summary of how the model works and why it was selected follows below:

- **The UK Space Agency used a third-party consortium funding and delivery model to deliver CEOI programmes.** This model provides the UK Space Agency with funding oversight but also leverages EO expertise, as well as academic and industrial partners, to distribute competitive grant funding within the sector. At the same time, however, it presents risks, including insufficient oversight or engagement with grantees by the UK Space Agency.
- **The CEOI programme is constructed to ensure neutrality**. The CEOI uses organisational security system agreements and operating practices to avoid potential conflicts of interest and inadvertent IP sharing. The main roles within the CEOI are its director, co-directors, directors of technology and of science, as well as technology project support and operations (contracts and projects). Particularly in the most recent renewal contract, the CEOI includes a broad group of advisors, adding capabilities around developing business cases and links to ESA.
- **The CEOI model provides impartial support to grant holders**. A key benefit of the CEOI's delivery model is that its experts can advise applicants at the bidding stage, helping to improve R&D concepts and ultimately enhance outcomes. The consortia's technological expertise and successful working relationship with ESA were also cited as benefits that a grant distribution programme alone could not achieve on the same scale.[Error! Bookmark not defined.]
- **The CEOI's model has had a positive effect since its inception in 2007.** The model delivers a level of transparency that the UK Space Agency, a research council or another government agency could not achieve.[126] Despite no explicit rationale for the UK Space Agency's (originally NERC and the Department for Trade and Industry) initial choice to fund the CEOI in this way, the most recent evaluation assessed the value of outsourcing the CEOI, concluding that the CEOI offered a credible mechanism and platform for EO stakeholders to develop their technologies.

5.3. CEOI Processes

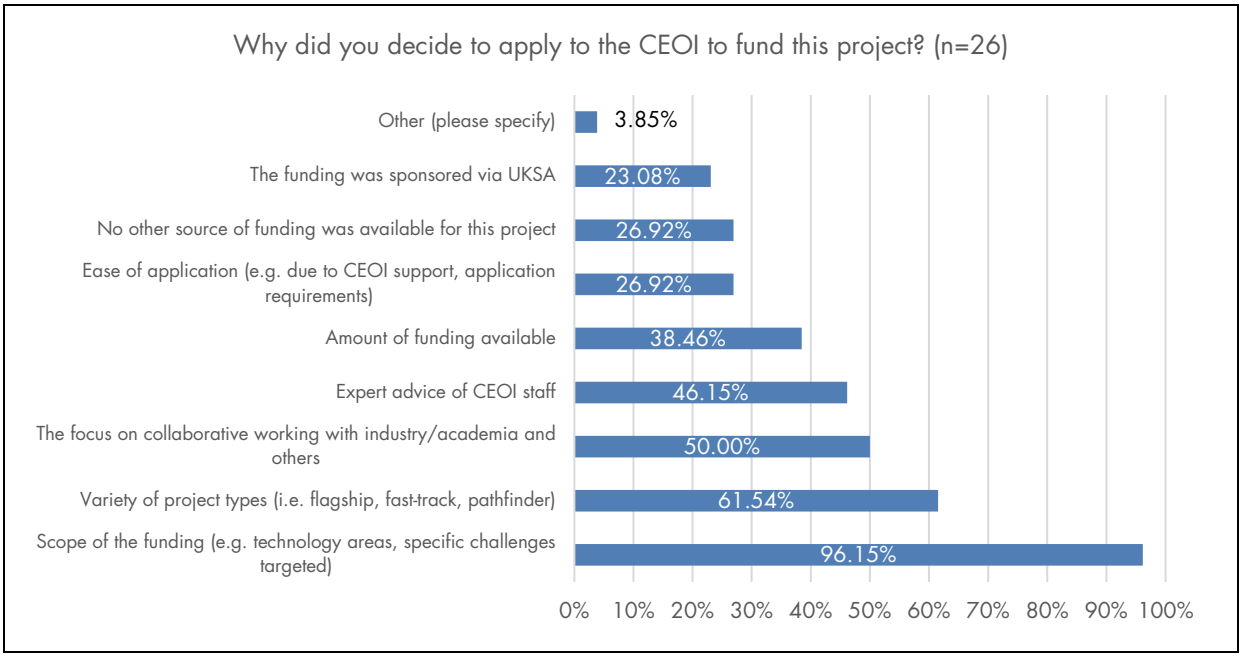
The results presented below summarise those reported in the interim report.

5.3.1. Application processes

Applicants cited several reasons for seeking CEOI funding, with the scope of funding being the primary factor: 96.2% applied due to the targeted technology areas or challenges.[127] The variety of project types – 'Flagship,' 'Fast Track' and 'Pathfinder' – was the second-most influential factor, highlighted by 61.5% of respondents in their decision to apply. Collaborative opportunities with industry and academia motivated 50% of applicants, and 46.2% were motivated by the expert advice from CEOI staff.

[126] UK Space Agency (2016a).
[127] INT_8B.

Figure 11: Rationale for applying for the CEOI programme funding



Source: RAND Europe. Project lead survey analysis.

Applicants valued the CEOI's support for early-stage technology development, a key feature of the programme. Low-TRL grant funding in the space sector involves significant risks, with returns potentially realised over long timescales. The CEOI fills a gap by investing in critical low-TRL innovations, deemed 'essential' by stakeholders, where other funding sources may hesitate due to the high risk and low profitability associated with early-stage investments. Stakeholders view this approach favourably and appreciate its opportunities for individuals with non-traditional backgrounds in the EO community.[128]

Project participants found the application process to be clear, rigorous and characterised by quick turnaround times, appreciating the clarity of the funding calls' needs and objectives as well as the CEOI's responsiveness.[129] The process's transparency, constructive feedback and independent expert review panel were considered strengths.[130] Participants also appreciated that the cadence and notification of funding calls enabled them to plan ahead,[131] although short tender cycles posed challenges for some. They suggested extending the turnaround time to three months and enhancing the transparency of application requirements to address these issues.[132]

5.3.2. Project management and delivery

Most project participants valued the CEOI's project management and reporting structures, which include a light process approach and regular updates to keep projects on track. Clear guidelines for monthly reports and update meetings balanced reporting with technology development.[133] While similar to industrial project management, which some prefer, this approach may put pressure on academic settings that are

[128] INT_7B; INT_3B.
[129] INT_6B; INT_9B.
[130] INT_6B; INT_7B.
[131] INT_12B; INT_7B.
[132] INT_4B.
[133] INT_7B; INT_9B.

unused to frequent reviews.[134] Participants appreciated the CEOI's flexible funding, which is tied to milestones, as well as its responsive communication.[135]

Project participants valued the knowledge, expertise and credibility of the CEOI team, which enhanced their projects through consistent engagement. Early CEOI engagement was beneficial for project success, as it aligned participants with key technological areas and ensured timely and responsive support.[136] Technical CEOI officers with engineering backgrounds also provided valuable feedback, strengthening project quality.[137] Participants also appreciated the roadmap for future technologies and investments.[138] However, one stakeholder noted potential challenges in scaling the CEOI to larger projects, including the need for adequate funding at higher TRLs and specialised support for organisations with limited space technology knowledge, which need addressing if the CEOI expands.[139]

Project participants reported delays in isolated cases, but they largely overcame these with minimal longer-term impacts on project delivery. One lead mentioned that staff changes at the CEOI caused delays in project starts,[140] while another noted lengthy startup timelines due to funding constraints from their company.[141] Participants also mentioned legal challenges, although the CEOI was cooperative after initial delays.[142] A few interviewees suggested improving email responsiveness and project closure, which could be addressed with additional resources, given the CEOI's budget constraints and inability to carry funds over from one financial year to the next.[143]

Although the COVID-19 pandemic caused disruptions, the CEOI overcame these challenges. However, UK-wide lockdowns during the 2020–2021 period notably affected research projects, hindering experimental work and in-person collaboration. Participants suggested that six-week review intervals might have been unnecessary during this time.[144] COVID-related delays in physical testing contributed to delays in project completion.[145]

Overall, project delivery was smooth, with most projects delivered on time and within budget. One project lead faced challenges with rapid spending due to the CEOI's March 2025 contract end date, which affected smaller academic projects.[146] Another had to change project goals after underestimating the costs of custom optics, but appreciated the CEOI's accommodating nature and its understanding of technological innovation needs.[147]

Part of this process evaluation involved conceptualising potential delivery models for future CEOI funding rounds, as outlined below.

[134] INT_2B; INT_3B.
[135] INT_7B.
[136] INT_4B.
[137] INT_9B; INT_7B.
[138] INT_9B; INT_7B.
[139] INT_10B.
[140] INT_10B.
[141] INT_12B.
[142] INT_10B.
[143] INT_12B; INT_9B.
[144] INT_3B.
[145] INT_9B.
[146] INT_7B.
[147] INT_3B.

5.4. Alternative delivery models

We consider the CEOI delivery model on a spectrum, ranging from an expanded version of the current model to a centralised in-house model run by the UK Space Agency, and include the pros and cons.

Table 5: Comparison of CEOI governance and delivery models

Governance/delivery model	Pros	Cons
Current model: External to the UK Space Agency, built from a consortium of EO companies and academics. Designs, delivers, and administers the funding.	Independent from the UK Space Agency but retains oversight and accounting, led by sector experts plugged into UK and global EO needs.	Less UK Space Agency control over design and delivery; the CEOI does not benefit from the UK Space Agency's capacity in monitoring and evaluating projects, leading to workload issues. Full-time program managers do not discharge grants.
Enhanced/expanded model: Enhanced resources to buy out more of the current CEOI leads' and administrators' time.	Capacity issues for rapid grant distribution addressed, including M&E.	Cost implications.
More centralised model: Pulling back the administration of CEOI funding to the UK Space Agency but retaining CEOI to help choose projects.	The UK Space Agency may better handle M&E and grant distribution due to its heritage, including in M&E.	Less ability to take advantage of the technical knowledge and relationships built by the CEOI. The UK Space Agency is less tuned into the EO community than the consortium.
Fully centralised model: Funding is completely under the UK Space Agency design and delivery; no external involvement beyond peer review and consultations.	Operational oversight is more direct (e.g. for M&E and grant distribution). The costs would be lower overall.	The benefits cited by previous evaluations of the outsourced model would be lost unless the UK Space Agency builds up the capability to match them.

We presented these options in our consultations with the CEOI, the UK Space Agency and wider stakeholders and summarise the responses below:

- **The UK Space Agency would not be able to match the CEOI's EO expertise in-house:** Although the UK Space Agency employs staff experienced in EO science and engineering, it does not have the in-house capacity to devote the same amount of specialised support that the CEOI currently provide to applicants and grant holders.
- **Internal financial deadlines create limits on project progression:** The the UK Space Agency's current budgetary restraints do not currently allow funds to be carried over from one financial year to another. This situation poses risks to project teams, as they have limited flexibility around delays towards the end of the financial year.
- **The lack of a long-term budget leads to a more challenging bidding process for applicants:** The short turnaround (three months) by which CEOI can give notice of upcoming calls is a challenge for applicants, particularly for businesses that need time to build an internal business case before they can start bid writing.[148]

[148] CEOI_UKSA_Group_Interview (2025).

- **The recent frequent restriction to one-year funding cycles reduces the CEOI's agility:** Much of the CEOI staff time is devoted to administration, exacerbated by squeezing additional calls per year into the schedule due to wider UK Space Agency underspends.[149] This situation reduces the CEOI's capacity to plan strategically, identify potential disruptive technologies or be proactive about upcoming EO trends.[150]
- **Adopting a longer-term plan with a consistent call cycle can reduce bottlenecks. Pivoting to a two- to three-year funding period** could reduce bottlenecks by increasing the time in the FY cycle that the CEOI can support R&D projects and offer a greater level of project coverage and competitiveness.[151] Furthermore, two to three calls could be planned at regular intervals over the five-year cycle to support industry, academic and organisational planning.[152]

5.5. Future opportunities and challenges

Future trends in the wider EO sector and the CEOI's role in it were discussed during the policy roundtables and interviews with the UK Space Agency and the CEOI. This sub-section presents these results, triangulating and substantiating the findings with other sources to provide suggested paths forward.

The UK's current contribution to EO focuses heavily on improving interconnectedness and breadth.[153] The CEOI's consortium approach is a testament to that strategy. However, it is an uncommon one for the UK Space Agency, which has brought up some issues regarding how best to govern and financially manage this model. A future opportunity for developing a centre of data exploitation, built in a format similar to CEOI (e.g. based on ESA Φ-lab[154]), could help ensure the UK remains at the forefront of EO data exploitation as well as instrumentation.

The CEOI and other the UK Space Agency and ESA programmes have enabled technologies to reach mid-TRLs, but more work is needed to continue that development upstream and downstream. In practice, the UK has leveraged capabilities across the EO value chain, from conception to instrumentation, manufacturing, data processing and exploitation, excluding launch at present. Current expertise outside the CEOI and UK subsidiaries, such as Airbus UK, remains heavily focused on data exploitation through organisations like the Met Office, ESA Climate Office and Lloyd's insurance. Our consultees recommended that the UK Space Agency could invest more in higher-risk, potentially disruptive technologies, acknowledging that leadership in a sector is often derived through first-mover advantage. A national drive to invest in prospective or low-TRL technologies that the UK aims to lead in was suggested, including long-term investments in facilities and infrastructure. Part of this can and should be achieved via the CEOI mechanism.

A 2023 market analysis of UK-based EO companies showed major strengths in the quantity of EO companies operating in the product and analysis markets (~90% of all UK-EO companies as of 2023),

[149] CEOI_UKSA_Group_Interview (2025).
[150] CEOI_UKSA_Group_Interview (2025).
[151] CEOI_UKSA_Group_Interview (2025).
[152] CEOI_UKSA_Group_Interview (2025).
[153] Findings from Roundtable 2: CEOI adjacent.
[154] ESA Φ-lab (2025).

highlighting UK heritage in that area.[155] Conversely, many of these are small and medium-sized enterprises (SMEs) or spinouts from academia (with <10 staff), which could be seen as oversaturating the market at the SME level. This oversaturation may contribute to a bottleneck, with an overly competitive micro and small firm EO ecosystem that reduces accessibility to UK Space Agency /ESA funding and increases the risk of failing to spin out. Such a bottleneck could prevent advancements in the market and horizontal integration of capabilities across the EO value chain.

The UK's current goals to further commercialise the EO sector were highlighted, along with key challenges, including an overemphasis on open data, public-focused EO programmes, market fragmentation, and uncertainty surrounding raw data. These were underlined by views that low-TRL development should continue to be supported without undermining higher-level mission-based or higher-TRL operationalisation. Roundtable discussions, followed by comments from the CEOI, recommended that the UK Space Agency adopt a new EO strategy to promote a more EO-specific approach to innovating and growing the UK space ecosystem.

[155] Red Kite (2023).

6. Conclusions

The CEOI programme is a key feature of the overall UK EO landscape, funding innovative projects that lead to enhanced technological progression and promising mission concepts. The programme is well-liked by grant recipients, with many calling for the CEOI's budget to be expanded and its funding extended across more than one financial year. The programme is largely well-run, though delivery partners have struggled to administer the funding within one financial year when additional calls are added, leading to difficulties in collecting and monitoring data.

6.1. Conclusions

The following conclusions summarise findings from the preceding chapters, organised by the CEOI's 2019 objectives:

> - **Economic Impact:** Develop EO technologies that increase exports and economic growth.
> - **Return on UK Government Investment:** Maximise the benefits derived from UK funding to ESA and other institutional bodies.

- **It is too soon to determine whether the CEOI will deliver good value for taxpayers' money, though there are early signs of potential for substantial future benefits**. Since our economic evaluation is subject to notable data gaps, we chose to focus on 39 recent projects (Calls 11–16) for which we have some data on economic impacts. This decision may have introduced selection bias into our results, since projects that did not respond to our surveys may have realised minimal benefits.
- **The real discounted (Present Value (PV), 2024/2025) and attribution-adjusted UK benefit of the CEOI (Calls 11–16) stands at least £30.2m to date.** Three large ESA contracts drive this total; thus, the results hinge on the success of a small subset of projects. If we include expectations, the PV benefit of the CEOI (Calls 11–16) rises to at least £57.6m. Furthermore, many benefits of the CEOI are intrinsically challenging to monetise, so that any quantified estimates will likely underestimate the programme's full benefits.

> - **Innovation:** Keep the UK at the forefront of EO technology development by supporting new and innovative ideas that offer tangible benefits to future missions.

- **The CEOI fills an important gap in funding low-TRL UK EO projects and supporting their development to higher levels.** With an average project TRL progression rate of 2.2 points, the CEOI is delivering value by supporting project teams to progress their EO technologies. Due to

their focus on low-TRL projects, the CEOI is also enabling wider access to the EO market among smaller organisations, diversifying the UK EO sector and promoting innovation.

- **Coordination among government, academia and industry strengthens the UK EO and space sector, with the CEOI enabling such collaboration.** The programme's funding model, as well as the events and networks that the CEOI facilitates, are recognised for encouraging collaboration and the cross-pollination of ideas.

> ➢ **Capability:** Strengthen capabilities in which the UK already leads, has the potential to lead or could overtake existing capability elsewhere.

- **The UK is a key player in global EO technology development, and the CEOI plays a crucial role within the ecosystem.** The progression pipeline from CEOI-funded projects to ESA funding or involvement in international missions is evident, contributing to the UK's international standing. The UK's contribution to international EO scholarship and academic publications is also significant, partly facilitated by programmes such as the CEOI.
- **The current CEOI model has advantages due to the level of stakeholder buy-in, programme transparency and support for international funding down the line.** The CEOI's match-funding model and collaborative approach ensure ownership among stakeholders. At the same time, the team's technological expertise and successful working relationship with ESA are key to promoting access to future funding and involvement in international missions.
- **However, the current CEOI model also has drawbacks that merit exploring alternative delivery models.** This report presents three examples of alternative delivery models. While an enhanced/expanded model could enhance the CEOI's offer, there are cost implications. For example, a more centralised model could improve grant distribution but would miss out on the CEOI's knowledge and networks. A fully centralised model would enhance operational oversight, but would struggle to generate the same benefits as the CEOI.

6.2. Recommendations

The following recommendations are intended to help improve CEOI's delivery, outcomes for projects and overall value that the programme brings to UK EO and the taxpayer:

- **The CEOI's funding support for low-TRL EO technology is vital for UK EO, and support at these development stages should be maintained.** Adapting the CEOI model or expanding the programme to support higher TRL projects should not neglect this earlier development stage. However, there are also arguments for the CEOI to focus on supporting disruptive technologies and longer-term projects to prevent innovation bottlenecks in the UK EO ecosystem.
- **The CEOI model can build on its strength in connecting partners, sharing knowledge and enabling collaboration.** The CEOI team's expertise and networks are significant advantages of the current programme model, bolstering the UK's ability to bring together space industry, academia and government. The benefits and disadvantages of alternative delivery models must be carefully weighed against the current CEOI model and its strengths in facilitating collaboration.

- **Sustaining or increasing funding for the CEOI is likely to deliver further value to UK EO.** Project participants throughout this evaluation overwhelmingly argued for the expansion of the CEOI programme, although such upscaling is likely to come with challenges and trade-offs. The recent increase in CEOI funding has led to an increase in projects and innovation in the EO sector, but also to a significant administrative burden, coupled with annual budgets. Extending the budget horizon to two years would enable the CEOI to deliver more value to the UK Space Agency by enhancing the quality of project bids and M&E reporting.
- **Beyond additional funding, the CEOI can benefit from strategic guidance from the UK Space Agency and the broader UK government.** Roundtable participants suggested creating a UK department for EO, akin to those in the US and New Zealand, to enhance strategy and capability building. A new UK EO strategy was recommended to enhance connections between the UK Space Agency, developers, and end-users, thereby boosting competitiveness in EO missions. This strategy involves a more risk-taking approach to funding, which fosters innovation.[156]
- **Clear prioritisation of EO market areas is needed for the CEOI to support the UK's leading data analysis capabilities and fill other niches.** For example, roundtable participants suggested focusing on UK sensor manufacturing and extending remote sensing from space-based to aerial and UAV technologies, aligning with synergies between UAVs and satellites. [157]
- **Our evaluation, particularly the economic evaluation, has been limited by incomplete data on project team impacts.** Capturing this data retrospectively, once projects have finished, is challenging, given that project teams have little incentive to respond to surveys and requests for information. Regular ongoing monitoring, concurrent with project delivery, will be key to capturing benefits as they arise in future. Regular quarterly monitoring should be implemented to capture the impacts of North Star Metrics on project teams, in line with mandatory UK Space Agency reporting requirements. Additionally, capturing expected North Star Metric impacts at the application stage, in line with other UK Space Agency programmes, could provide a valuable source of forecast data to compare against realised impacts.

[156] ESA (2020).
[157] Alvarez-Vanhard et al. (2021).

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Annex A. Interview overview

A.1. Interviewed organisations

CEOI
UK Space Agency
QinetiQ
University of Leicester
CEOI
Airbus
UK Space Agency
DSTL
NCEO
Met Office
Defra EOCoE
ESA/ ESTEC
University Cambridge
University of Strathclyde
Teledyne e2v
Queen's University Belfast
University of Nottingham
University of Edinburgh
STFC RAL Space
Craft Prospect
Cranfield University
Open Cosmos
Terahertz
University of Leeds
Leonardo MW Ltd

A.2. Interview protocol example

CEOI interview protocol – direct beneficiaries of grants

Interviewee name	
Role and organisation	
Interviewer	
Interview date/time	
Involved in which funding call(s)?	

A.2.1. Ahead of the interview

The interviewee has been selected as they were a project lead in the CEOI. Project leads are being interviewed for a comprehensive and robust account of processes and impacts. Prior to each interview, familiarise yourself with the background documentation available (quarterly reports, summary reports, final phase reports, etc).

A.2.2. Interview

Instructions for interviewer:

Begin by introducing yourself and providing some background to the interview. Please confirm the participant's consent to participate in the evaluation and recording.

A.2.3. Background to the research to be shared with the interviewee

Thank you for agreeing to take part in this interview. As you may know, the UK Space Agency has commissioned a consortium led by RAND Europe to conduct an independent evaluation of the CEOI programme. The comments you share in this interview will provide valuable insights to feed into the evaluation of this programme.

This interview should last from around 45 minutes to an hour.

Your participation in this interview is voluntary, and you can change your mind at any time. The information that you provide will be treated in confidence by the evaluation team.

We would like to use your inputs and request your permission for the following:

1. To use the feedback you provide, together with any additional information you choose to disclose ('Information') for the evaluation study.
2. We will provide **an anonymised version of this and** any analysis we carry out as part of the evaluation study with the UK Space Agency, for its own internal purposes only. However, due to the number of projects in each sub-programme, complete anonymity may not be possible.
3. The UK Space Agency expect to publish **aggregate, unattributed results** of the evaluation, which includes analysis of information from these interviews.

We would like to audio-record the discussion for analysis purposes, which will be used to help us accurately collect findings for the research. The recordings will be securely stored and retained by us and destroyed by the end of the evaluation. **Are you happy for us to proceed?**

A.2.4. Introduction

Instructions for interviewer:

This section includes brief introductory questions to understand which sections of the interview guide are most relevant to the interviewee.

This section shouldn't take more than a couple of minutes.

1. Could you please give an overview of your role and involvement in the CEOI programme?

Prompts:

i. *Which project(s) were you involved in as a project lead?*
ii. *Which funding call(s) were you a part of?*
iii. *Were you involved in any additional projects as partners?*

2. ***(if applicable)*** *Are you able to speak to the other projects you were involved in?*
3. ***(If applicable)*** Why did your organisation/ team decide to engage in more than one project under the CEOI?
4. ***Did your organisation make any additional applications to the CEOI at any other stage that were unsuccessful?***

Instructions for interviewer: If the interviewee made an unsuccessful application in addition to their successful application, questions __ - __ are relevant to ask.

5. **(If applicable)** Thinking specifically about the application that was not funded in the CEOI, did your organisation pursue this project by other means? **(If not, move on to question 5)**

If so, probe for:

i. How did you fund this project? (Private/ public/ own funds/ international?) Were there any co-investment opportunities?
ii. Who did you partner with?
iii. To what extent did the direction of travel of the project change? How and why did this happen?
iv. What have been the project's key achievements to date?
v. What have been the main differences between the project funded under the CEOI and this one?

6. **(If applicable)** Why didn't your organisation choose to pursue this project?

Probe for:

i. Were there any funding issues?
ii. How would the direction of the project have had to change? Was this possible?
iii. What could have been the key achievements to date?
iv. What were the key parts of the CEOI that this project was dependent on?

A.2.5. Application and assessment processes

Instructions for interviewer:

This section aims to understand the applicant's views on the application process.

Note that interviewees may not be able to recall certain information, as some applications were made 10+ years ago.

7.

a. Can you please describe your application process to the CEOI funding call?
b. How clear was your understanding of the needs and objectives of the funding call? And how did these align with your own?
c. Were you provided with enough time and information to form your consortium and prepare your submission?
d. **(If applicable)** Were there any differences in the application process for the other projects you were involved in for different CEOI funding calls?

8. Can you please describe your experience in the application assessment process

Prompts:

i. How transparent was the application assessment process?
ii. Were you provided with appropriate feedback?
iii. **(If applicable)** Were there any differences between funding calls for the projects you were involved in?

9. Are there any ways in which the application or assessment processes could have been improved or streamlined?

A.2.6. Other CEOI processes and design

Instructions for interviewer:

This section aims to understand the stakeholder's views on the processes, management and design of the CEOI. We will use this information to refine the process maps and may follow up with interviewees for review.

10. What elements of the CEOI's design and processes worked particularly well in your view? (ask the interviewee to specify which funding call they are referring to, or whether they are referring to the CEOI as a whole)

Prompts:

i. How satisfied was your organisation with the programme?
ii. Were there any process barriers to delivering projects on time and within budget?

b. What processes present best practice opportunities for future programmes or iterations for CEOI funding calls?

c. To what extent do you think the CEOI holds potential for scaling up? What would this involve, and is there a sufficient market demand for it?

11. Which parts of the CEOI's design and processes do you think worked or didn't work well for EO companies?
    i. Do EO companies need additional support to compete more effectively on an international stage for missions?

12.

a. What are the current funding mechanisms/methods used in the CEOI's delivery? To what extent do you think these mechanisms are appropriate? (i.e. match funding or grant funding).

b. Were other funding mechanisms considered as part of the CEOI's delivery plan?

Probe for:

i. Why were alternate choices not chosen?
ii. Do any of these present opportunities worthy of merit?

13. Were efforts taken to ensure that EDI factors were considered in the design and delivery of the project(s) you were involved in? Were there any challenges in implementing EDI factors?

A.2.7. CEOI impacts

Instructions for interviewer:

This section aims to understand the stakeholder's views around the impacts resulting from the CEOI.

14. From your perspective, what have been the main impacts that have occurred as a result of the project(s) you were involved in?
    i. Did the project(s) contribute to the development of new UK EO instrumentation and technologies? (e.g. TRL, CRL and SRL progression data).
    ii. Did the project(s) achieve commercialisation as a result of involvement with the CEOI?

(Related to the CEOI added value programme)

15. To what extent has the CEOI:

    i. Helped your organisation to leverage new contracts and investment opportunities?
    ii. Enabled you to generate new knowledge exchange opportunities?
    iii. Enabled you to create new capabilities within the project(s)?

16. How has good value for money been demonstrated in the project(s)?

Prompts (areas of VfM that we are considering – no need to ask about all of them):

i. New publications and citations.
ii. New strategic partnerships.
iii. Additional funding leverage by strategic partners.
iv. Additional competitive research funding.
v. New and improved products/services, processes or practices.
vi. New patents, licenses and IP.

vii. *New and active organisations/businesses supported (spin-offs, start-ups, SMEs and other commercial businesses) Number of new jobs created and retained.*

17. We are also interested in understanding your perspectives on the programme's influence on the wider EO technology sector as a whole. To what extent do you think the CEOI has contributed to the growth of the EO sector?

Probe for:

i. *New and strengthened relationships.*
ii. *New knowledge.*
iii. *Training examples.*
iv. *New and active organisations (spin-offs, start-ups, SMEs and other commercial businesses).*
v. *Private and public sector funding.*
vi. *Productivity increase.*
vii. *International reputation.*

18. Counterfactual question: What might have been expected to happen without CEOI investment?

Prompts:

i. *Technological development differences*
ii. *Formations of partnerships*
iii. *Co-investment opportunities*
iv. *Other impacts.*

19. Did the CEOI enable your project to collaborate with international fora?

Prompts:

i. *Access to international knowledge, people, skills and facilities.*
ii. *International EO reputation in terms of establishing new international collaborations and accessing/leveraging international funding.*

20. To what extent do you think the CEOI has affected the UK's credibility and reputation among the international EO community?

A.2.8. Closing

Instructions for the interview

This section aims to wrap up and allow the interviewee to add anything they might have missed when answering a previous question or regarding a topic we haven't asked about. Please thank the interviewee for their time and participation.

This section should be relatively short (around five minutes). If the interviewee has many comments to share at the end, please feel free to give them more time if available or invite them to share further comments in writing.

21. If you were designing the CEOI from scratch, what aspects would you remove? What aspects would you add?

22. Is there anything you would like to discuss that hasn't been touched upon already?

Thank you for taking the time to answer these questions. We might follow up with some project-specific output questions if that's alright? If you have any further questions or comments, please feel free to email me or the project manager, Theodora Ogden.

Annex B. Survey overview

B.1. Surveyed organisations

Organisations surveyed
TAS UK Ltd
National Oceanography Centre
STFC RAL Space
Leonardo MW Ltd
Surrey Space Centre, Univ of Surrey
University Cambridge
University of Strathclyde
University of Leeds
University of Glasgow
University of Oxford
Cranfield University
University of Cardiff
University of Edinburgh
University College London
University of Leicester
Durham University
University of Reading
Queen's University Belfast
National Physical Laboratory
MSSL
TAS UK Ltd
Airbus DS
Earth-i Limited
Craft Prospect

B.2. Survey questions

Survey topic	Survey questions
Background Welcome to the survey that we, RAND Europe, are conducting as part of an evaluation of the CEOI (Centre for Earth Observation Instrumentation), commissioned by the UK Space Agency. The evaluation is led by RAND Europe, with partners, know.space, as well as earth observation (EO) experts, Aravind Ravichandran & Luca Budello. It will run until March 2025 and will culminate in a public final report (with commercially sensitive information redacted). The aim of the evaluation is to explore how well the programme has been delivered and to what extent it has achieved its objectives, from its inception to the present day. The CEOI comprises two programmes, the EO Instrumentation Programme (EOIP), launched in 2007, and the EO Technology Programme (EOTP), announced in November 2022. This survey is aimed at all project leads funded by the CEOI under EOIP and/or EOTP from all funding calls. Other research methods will include interviews, case studies, policy roundtables and analysis of project reporting. To avoid duplication and respondent burden, this survey only asks questions that cannot be obtained by those other means and by existing data sources. **This survey** The first part of this survey asks briefly about the most notable achievements of your work, before moving on to the capabilities developed in the context of the funding you received. The remainder of the survey asks about the commercialisation of the technology developed, international missions, your participation in events, and the new partnerships and knowledge exchange that may have happened. Finally, the survey asks about your perception of the processes carried out in the context of the EOIP/EOTP, and the future of the programme. This survey is made up of closed and open free-text questions, and should take 10-15 minutes to complete. **Confidentiality and data** None of the questions in the survey are mandatory, and you are able to withdraw at any time. You are free to request the withdrawal and deletion of your submission and data at any point in time during the course of the study. **By completing this survey, you agree to the terms of the privacy policies outlined by RAND Europe and the UK Space Agency, which are linked below, and the data you provide for use in this project only.**	

All data and information provided will be considered as confidential, it will only be used by RAND Europe for the purposes of conducting the evaluation, and we will not share with anybody (including the UK Space Agency) any raw response data that is directly attributable to you. Any wider publication of results from the survey will only be in a synthesis and anonymised form in our reporting. Please see RAND Europe's and the UK Space Agency's privacy policy for more information.

If you have any questions, please feel free to contact Theodora Ogden, the RAND Europe study manager (togden@randeurope.org), or Joe Hicks at the UK Space Agency (joe.Hicks@ukspaceagency.gov.uk).

Understand the profile of the respondent	1. Before securing your EOIP/EOTP award, had you previously: a. Secured any other grant funding (UK Space Agency or not) for EO R&D as a lead partner. b. Participated in EO R&D via other means (e.g. private contracts, partner on projects led by others).
Tech/achievements	One way of measuring technological development is by using the Technology Readiness Level (TRL) scale, which describes the different stages of development a solution might go through. We are interested in where the solution(s) were at the beginning of your project, when the project finished, and now. For example, a new sensor might have only been proven in theory (TRL 3), by the end of the project, it was tested in an operational environment (TRL 7), and now it has actually been sold to customers (TRL 9). 2. What was the TRL of the main innovation you developed as part of the project (e.g. product, technology, process, service) before receiving EOIP/EOTP funding, by the end of the project and now?

TRL levels	When you were awarded the EOIP/EOTP funding	By the end of the project	Present day
TRL 1- Research: Basic principles observed. Scientific observations made and reported. Examples could include paper-based studies of a technology's basic properties.			

	TRL 2- Research: Technology concept formulated. Envisioned applications are speculative at this stage. Examples are often limited to analytical studies.			
	TRL 3- Research: Experimental proof of concept. Effective research and development initiated. Examples include studies and laboratory measurements to validate analytical predictions.			
	TRL 4- Development: Technology validated in lab. Technology validated through designed investigation. Examples might include analysis of the technology parameter operating range. The results provide evidence that envisioned application performance requirements might be attainable.			

	TRL 5- Development: Technology validated in relevant environment. Reliability of technology significantly increases. Examples could involve validation of a semi-integrated system/model of technological and supporting elements in a simulated environment.			
	TRL 6- Development: Technology demonstrated in a relevant environment. Prototype system verified. Examples might include a prototype system/model being produced and demonstrated in a simulated environment.			
	TRL 7- Deployment: System prototype demonstration in operational environment. A major step increase in technological maturity. Examples could include a prototype model/system being verified in an operational environment.			

	TRL 8- Deployment: System complete and qualified. System/model produced and qualified. An example might include the knowledge generated from TRL 7 being used to manufacture an actual system/model, which is subsequently qualified in an operational environment. In most cases, this TRL represents the end of development.			
	TRL 9- Deployment: Actual system proven in operational environment. The system/model has been proven and is ready for full commercial deployment. An example includes the actual system/model being successfully deployed for multiple missions by end users.			

3. To what extent have the technology or solutions developed in your project reached their intended user base? Select all that apply:
    a. Launched as part of a mission
    b. Sold to customers

c. Being applied by practitioners
d. Being used / further developed by other researchers
e. Other (please specify).

4. Have the technological solutions created by your project led to any of the following benefits for end-users? *Select all that apply (Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A'):*
    a. Supported the development of low-mass, cost-effective EO instrumentation for institutional and commercial markets.
    b. Increased knowledge exchange between the academic and industrial EO community.
    c. Promoted the CEOI's capabilities, technologies and achievements of the UK EO research and industrial sector.
    d. Leveraged external follow-on funding.
    e. Improved understanding within the UK EO community of opportunities presented by CEOI, the UK Space Agency and mainly ESA, the EU/Copernicus.

Have the technological solutions created by your project led to benefits in the following areas? *Select all that apply (Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A')*:

a. Environment and Net Zero targets
b. National security
c. Engagement with students / early-stage career profiles for employment in space/STEM.

+ free text box to capture rationale/qualitative information

How has your technology helped advance UK EO capabilities?

Category	Type	**Supported** existing capabilities	**Advanced** existing capabilities	**Enhanced** new capability
Data	Data processing			

		Data modelling			
	Passive imagery	Panchromatic			
		Multi-spectral			
		Pan-sharpened			
		Hyper-spectral			
		Microwave radiometry			
	Active imagery	SAR			
		Lidar			
		Radar altimetry			
		Radar scatterometry			
		GNSS-R			
	Parameters	Spatial resolution			
		Revisit time			

Commercialisation	5. Can you provide an estimate of the value of EO-related contract(s) won and investment that you would attribute to your involvement in EOIP/EOTP, if applicable? a. Public funding (e.g. public service contracts, further R&D grants) (free text box) b. Private funding (including venture capital) (free text box) c. Of the above, what amount was from non-UK-based sources? (free text box) 6. To what extent has the EOIP/EOTP funding allowed you to capture more of your domestic and international markets for your products/services between the point of your award and the present day, if applicable? a. Domestic (per cent gain in market share attributed to the funding) b. International (per cent gain in market share attributed to the funding). 7. Have you applied for and/or been granted patents specifically for technology developed as part of your EOIP/EOTP funding? a. Patents applied for *(drop-down menu to choose a number between 1 and 10)* b. Patents granted *(drop-down menu to choose a number between 1 and 10)* c. *Extra box*: If a patent was granted, what was the patent number?

	8. How much total revenue have you generated through IP licensing across patents? free text 9. Have any spin-outs been created from the work conducted as part of the EOIP/EOTP funding? a. No *b.* Yes (please specify how many, company names and approximate number of employees).
Jobs/capabilities and skills	10. Has the EOIP funding enabled the development of new skills and capabilities at your organisation <u>from the point of your award to the present day,</u> such as: (*Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A')*: a. Your ability to lead/participate in bids for international missions (e.g. ESA, bilateral). b. Your ability and capacity to export your technologies. c. Maintain and improve the technical knowledge and skills of your workforce/yourself in developing innovative EO instrumentation. d. Ability to access international expertise and facilities. e. Increased ability to commercialise research outputs (e.g. IP, patenting, products). f. Increased ability to capture commercial contracts. g. Reputational benefits. 11. As a result of the EOIP/EOTP funding you received: a. How many EO jobs were created? (free text box) b. How many EO jobs were retained? (free text box) c. How many PhDs were supported? (free text box) d. How many apprentices were supported? (free text box) e. How many exchanges were supported (e.g. sabbatical of employees within the industry)? (free text box) 12. To what extent did your organisation experience commercial benefits as a result of the EOIP/EOTP funding you received?

	a. Overall company growth b. Increased wages c. Increased revenue from sales/licencing (actual and expected) d. Increased productivity/efficiency. 13. Did you incur any additional costs (over and above those covered by EOIP/EOTP and your committed match funding)? a. No b. Yes (please specify a specific £ figure if possible and/or staff time).
International missions	14. How many submitted ESA EO-related mission bids have you been involved in (either as lead or partner) that **included technology you developed as part of your EOIP/EOTP grant**? a. Number of ESA EO-related mission applications *(drop-down list 1–10)* b. Number of successes *(drop-down list 1–10)* c. Value secured in GBP, only in relation to your contribution, not the total contract value *(free text box)* 15. Have you been involved in any other international EO-related mission bids (either as lead or partner) that **included technology you developed as part of your EOIP/EOTP grant**? If applicable, can you provide any details concerning the number of bids submitted, successful bids and value? *(free text box)* 16. To what extent was the technical support you received as part of the EOIP/EOTP adequate to help you compete for international missions? *(Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A').*
Events 1/2	17. Did your organisation take part in one or more of the following activities organised by the CEOI (select all that apply): *(if any selected, see if possible to activate the 'events' section later without jumping straight to it):*

	a. Challenge workshop. b. Technology strategy workshop. c. Training workshop. d. Other workshops (please specify). e. CEOI Earth Observation Conferences (CEOI annual conferences or National EO Conference). f. Technology and projects showcase events. g. CEOI support for developing concepts for ESA Earth Explorer Rounds. h. CEOI supported PhD studentships (as a sponsor, supervisor or as a student). i. CEOI training and development programme. j. Industry consultation workshop. k. SME event.
Events 2/2	18. Did your participation in events/workshops organised by the CEOI lead to: (*Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A'*): a. Increased knowledge and skills b. Networking c. New collaborations d. New commercial outcomes e. New investments. 19. To what extent have the public event(s) organised by the CEOI allowed you to showcase your achievements? (*Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A'*).
Partnerships / knowledge exchange / networks	20. As a result of the EOIP/EOTP funding, did you form any new partnerships (i.e. partners with which you had not had a formal project collaboration before) or collaborate with any of the following stakeholders between the point of your award and the present day? If applicable, how many new partnerships or collaborations? (*tick box + drop-down menu 1–10 next to each*):

a. Academic/university
b. Private sector (e.g. industry)
c. Third sector (charity/non-profit/NGO)
d. Public sector (e.g. policymakers, local government).

21. To what extent have existing partnerships (i.e. partners with whom you previously had formal project collaborations) been strengthened as a result of your EOIP/EOTP funding? (*Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A'*).

22. To what extent has EOIP/EOTP funding allowed you to widen your pool of partnerships on a geographic level between the point of your award and the present day? E.g. it may have allowed you to work with particular companies/academics in a certain country, which was not possible without the funding.
Please select all that apply.

	To a large extent	To a moderate extent	To some extent	To no extent	Don't know/ N/A
Local/regional level					
UK level					
International level					

Counterfactual

23. Did you consider any other funding programme when applying for EOIP/EOTP funding? (Y/N)
a. (if yes) What was the name of the alternative funding programme and the funder?
24. To what extent would the benefits of the programme for your project have come about via other means if you **had not** received EOIP/EOTP funding?

	All benefits would have	Most benefits would have been achieved	Some benefits would have been achieved	None of the benefits would	Don't know/ N/A

	been achieved			have been achieved	
TRL increases					
New Intellectual Property developments					
Demonstration opportunities					
Technology commercialisation					
Development of existing and new partnerships					
New jobs created / existing ones retained					
New knowledge and skills developed					
Training and development delivered					

25. Could you have undertaken your project without EOIP/EOTP funding?
    a. Yes, at a larger scale
    b. Yes, at the same scale
    c. Yes, at a smaller scale
    d. No
    e. Not sure / N/A,

Processes / how well the programme responds to the needs of the sector

26. To what extent was the funding you secured sufficient for addressing your original objectives? (*Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A').*

27. From your experience, how satisfied were you with the following processes within the EOIP/EOTP? *(Likert scale 1–5: 'To a large extent', 'To a moderate extent', 'To some extent', 'Not at all', 'Don't know / N/A')*:
    a. Frequency of funding calls, e.g. number per year.
    b. Overall number of funding calls.
    c. Format used to announce opportunities.
    d. Strategic direction document provided to applicants.
    e. Bidding process (including intention to bid notification as well as submission of the bid itself).
    f. The eligibility and selection criteria for the programmes.
    g. Mode of assessments for the bids.
    h. Time from application to award.
    i. Contractual conditions of the award.
    j. Post-award support.
    k. Programme monitoring (including monthly progress reports, quarterly reports, mid-project reviews and final project report).

28. Do you have any suggestions on how processes within the programme could be implemented differently in the future? (timeliness, transparency, support). (*free text box)*

29. To what extent did your project take into consideration issues of equality, diversity and inclusion?

	To a large extent	To a moderate extent	To some extent	To no extent	Don't know/ N/A
Within the project (e.g. equitable access to training, team gender/ethnicity balance)					

	As part of the intended impact of the R&D (e.g. making EO data/resources available to underserved indigenous communities)					
Closing / Future of the programme	30. If there was one thing you would change about the EOIP/EOTP programmes to improve them in the future, what would it be and why?					