Written evidence submitted by the Minister for Science, Research and Innovation (DSIT)
(QUA0045)

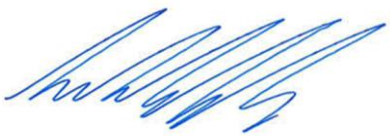
Dear Greg,

Further to your letter dated 26 April 2024, I am writing to you with information on the areas requested:

1. Data the Department is using to track the commercialisation of quantum technologies in the UK.
2. Work the Department is taking in collaboration with the Department for Education and the Quantum Skills Taskforce to develop the quantum skills plan alongside the £600m commitment over the next two years.
3. What assessment have the Department made around the natural resource requirements (eg water consumption, critical minerals) of quantum technologies?

I hope the written evidence contained in the annexes below is a useful resource for the Committee and complements the oral evidence the Department has provided. Please do not hesitate to contact me should you have any further questions.

Yours sincerely,



Andrew Griffith MP
**Minister for Science, Research and Innovation**
**Department for Science, Innovation and Technology**

## Section 1: Data the Department is using to track the commercialisation of quantum technologies in the UK.

The Department tracks the commercialisation of quantum technologies in the UK through:

1. a range of metrics on the growth of the UK quantum sector. The latest evidence was published online in December 2023 [link] and we intend to update this annually as new data becomes available.
2. monitoring the impact of the Industrial Strategy Challenge Fund Commercialising Quantum Challenge.

### UK quantum sector – key metrics

The December evidence update included the following metrics relevant to the commercialisation of quantum technologies:

- The UK was second in attracting private equity investment across 2012-2022, behind only the US. It has attracted 12% of global private investment into quantum technology companies between 2012 and 2022.
- The UK has approximately 11% of the world's quantum companies with 110 companies.
- The UK ranks highly for the number of businesses we have compared with our international competitors, across a broad range of quantum technology areas.
- The UK is second for the number of quantum companies behind the USA.
- A quarter of UK quantum companies have London-based headquarters and 47% have headquarters in either London or the South-East.
- The UK is fourth globally among inventor countries for International Patent Families (IPFs) in quantum technologies and first in Europe.
- The UK is the second most specialised country in quantum technologies out of the top ten inventor countries for International Patent Families.

The Department also has more recent data from Quantum Insider (sourced March 2024) on private equity investment. It shows that the UK remained second globally in attracting private equity investment into quantum companies over 2020-2023, having attracted over $900m investment over 2020-23, including approximately $280m in 2023 alone. Over 2012-2023, the UK attracted over $1bn in private investment into quantum companies and remained second globally over this period. As not all private equity investment is disclosed, our relative performance is hard to judge precisely.

### ISCF Benefits Monitoring

Innovate UK has commissioned independent monitoring for the Industrial Strategy Challenge Fund (ISCF) "Commercialising Quantum Challenge" on an annual basis. This monitoring work is intended to synthesise evidence on how effectively the ISCF is supporting the commercialisation of quantum technologies. Data are collected through an annual survey carried out by AnchoredIn for Innovate UK. The data is not currently in the public domain.

## Section 2: Work the Department is taking in collaboration with the Department for Education and the Quantum Skills Taskforce to develop the quantum skills plan alongside the £600m commitment over the next two years.

The Quantum Skills Taskforce was established in November 2023 to understand the current and future skills needs of the sector, promote existing skills programmes, and explore new opportunities to drive business investment in skills. The Taskforce is a small group chaired by Professor Sheila Rowan CBE, and includes representatives from industry, academia, learned societies, and relevant government departments, including the Department for Education (DfE).

To ensure that the taskforce can consider issues at an appropriate level of detail, it has adopted a working group structure based around five thematic areas:

- Apprenticeships and technical education, accredited short courses and continuous professional development
- Quantum on undergraduate programmes and master's degrees
- Researcher skills, PhDs, fellowships, and the academic workforce
- International recruitment and retention
- Quantum in schools and outreach activities

Each working group is also considering how diversity can be improved across their respective areas and sources of data that could be used to establish targets, monitor progress, and evaluate the effectiveness of interventions.

Through the taskforce structure we have engaged with over 100 representatives from across the quantum ecosystem so far this year. The taskforce will publish a report in the summer setting out its findings and key evidence. This will be used by the Department to guide future policy and skills investments.

We're continuing to deliver against the commitments made in the Quantum Strategy, which was evidenced by the range of announcements outlined by the Secretary of State at the Maths Summit in March. These include:

**Centres for Doctoral Training (CDT) and PhDs**
The number of quantum CDTs will more than double, increasing from two to five centres. This will see quantum CDTs at the Universities of Southampton, Bristol, Edinburgh, Strathclyde and UCL. A further 100 quantum PhD studentships will be created this year through a £14m investment in Doctoral Training Partnerships, funding quantum PhDs in every nation and region of the UK.

**Apprenticeships**
A pilot quantum apprenticeship programme through the Science and Technology Facilities Council. This programme, which is the world's first dedicated quantum apprenticeship programme that we are aware of, will support engineering technicians to enter the quantum workforce, with the first apprentices starting in 2025.

**Fellowships**
£14m is being provided for a new round of quantum career development fellowships starting in 2024, which will allow the best and brightest to develop their research careers within the UK.

**Funding**

These initiatives are being supported through an increase in funding for quantum skills programmes of over £60m. Across the National Quantum Technologies Programme, so far, partners have over £100m of funding committed for quantum skills initiatives up to 2034.

DSIT and DfE work closely together to deliver on the UK's Science and Technology Framework. The £600 million investment being made by DfE is to lay the groundwork for the delivery of the Advanced British Standard (ABS). This includes around £200 million over the next 2 years for the Levelling Up Premium (LUP), which will support schools and colleges to recruit and retain teachers in key subjects.

It is worth up to £6K per year after tax for early career teachers in key Science, Technology, Engineering and Maths (STEM) subjects in disadvantaged schools. DfE have expanded it to cover priority STEM and technical shortage subjects at all Further Education (FE) colleges for the first time, benefitting the disproportionate number of disadvantaged young people in FE. DfE are doubling the existing LUP payments to school teachers of maths, physics, chemistry and computing, and extending it to FE teachers of those same subjects and also construction, digital, early years and engineering and manufacturing.

DfE will make these payments in academic years 2024/25 and 2025/26 to improve recruitment and retention, addressing a priority raised by witnesses to the Commercialising Quantum Enquiry.

## Section 3: What assessment have the Department made around the natural resource requirements (eg water consumption, critical minerals) of quantum technologies?

There is no consensus on the future natural resource requirements of quantum technologies. This is due to the technological diversity of hardware platforms and uncertainty around how these will develop. As the technologies mature, we recognise the need for greater research into their resource and environmental implications. The sections below provide the Department's initial assessment of the topic and outlines future work in this area.

### Current assessment

Many quantum technologies will rely on critical minerals for their development. As quantum technologies become commercialised, minerals involved in the quantum supply chain may have a renewed focus on their 'economic vulnerability' in criticality assessments.

In terms of specific minerals and resources that are required for quantum technologies, previous work in the Department has outlined that caesium, rubidium and strontium are required for quantum fibre clocks, while helium-3 (an isotope of helium) is essential for reaching the low temperatures in dilution fridges used for quantum computing.

However, it is a significant challenge to comprehensively assess the future resource needs of the sector, given the technological diversity in quantum computing hardware platforms and uncertainties around how these will develop. For example, the supply chain, operational cost, and embedded carbon will likely differ largely between superconducting circuits and photonic systems. Similarly, the energy and water consumption requirements for quantum computers are also unclear – depending on the hardware modality, energy and coolant requirements may vary.

It is possible that quantum processing itself will be less energy intensive than classical computing. Quantum processing is expected to arrive at higher quality solutions many orders of magnitude faster (for certain tasks), leading to efficiencies in energy consumption when compared with classical technologies.

Quantum technologies could also offer other environmental benefits. The Government's Commercialising Quantum Technologies Challenge has funded several projects helping to address the challenge of generating and storing reliable, clean, and sustainable energy. For example:

- UCL startup Rahko have explored how quantum computing can be used to design and optimise new and efficient catalysts, with applications in developing cleaner fuel technologies and reducing environmentally harmful emissions in industry.
- The SPLICE project led by start-up QLM in collaboration with 10 other partners, including oil and gas firm BP and the National Grid, to develop quantum enabled gas sensors for detecting and visualising industrial gas leaks, helping to prevent greenhouse gas emissions.

**Future Work**

With the launch of 7 hardware testbeds at the National Quantum Computing Centre announced this year, it will be possible to gain greater insights on energy efficiency, coolant consumption, and critical mineral requirements across different quantum computing platforms.

The Quantum Infrastructure Review, which the Department commissioned from the Royal Academy of Engineering (RAEng), is set to be published imminently and will consider how critical materials are sourced for quantum technologies. This advice will then inform further work by the Department on the UK's quantum technologies supply chain, which we expect to provide additional insight into resource requirements of the technologies.

*May 2024*