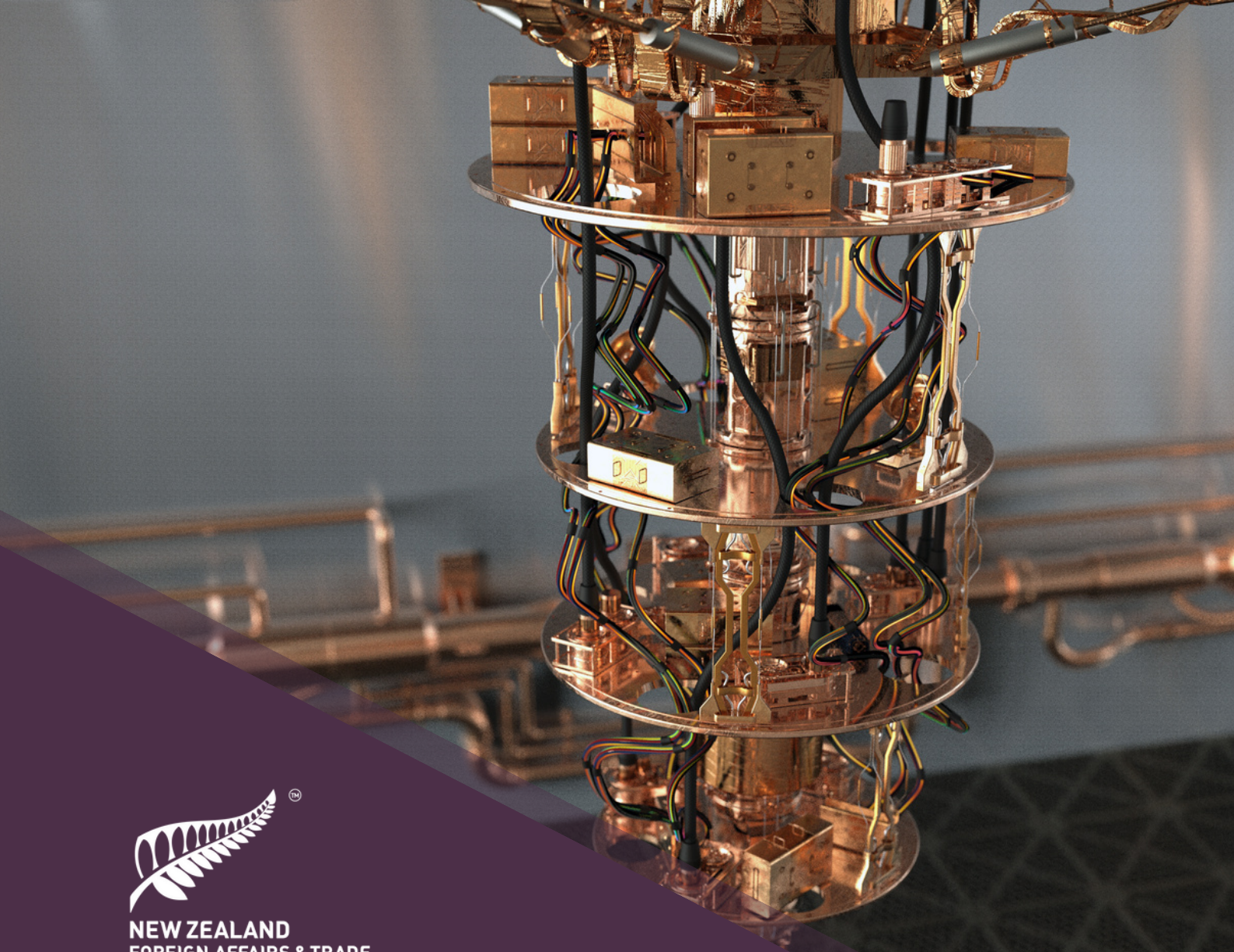

NEW ZEALAND
FOREIGN AFFAIRS & TRADE
Manatū Aorere

JANUARY 2024

Quantum and Photonic Technologies in the UK

MARKET INTELLIGENCE REPORT

Summary

Prepared by the High Commission in London in consultation with MBIE.

- The UK is building research and commercial strength in a range of quantum technologies including sensing, communications, timing and computing. It is currently ranked third behind the US and China for research output and second after the US for the number of quantum companies and amount of private investment.

- Practical applications of quantum technologies are beginning to emerge, including the first commercial deployment of a quantum secure network in London and a wearable quantum enabled brain scanner, which is being deployed in UK hospitals. Overall quantum remains at an early stage, with most technologies still in the research, development or demonstration phase.

- The UK's progress has been underpinned by significant public and private investment, with the government investing GBP1 billion from 2014-2023 into research and commercialisation. In April 2023 the UK announced a new National Quantum Strategy, which is underpinned by GBP2.5 billion over ten years and organised around five missions.

- International collaboration is central to the UK's approach. The UK wants to be an integral part of a global supply chain in quantum technologies and to attract investment and international talent. It is taking an open and collaborative approach to research and forming bilateral research and commercial partnerships with countries such as the US, the Netherlands, Singapore and Australia.

- With niche research and commercial strengths in aspects of quantum and photonics, underpinned by new government - government arrangements and joint association to Horizon Europe, New Zealand is well placed to benefit from the UK's investments in international research collaboration, as well as the growing demand for quantum and photonic technologies in the UK.

Report

In recent decades there have been major developments in our understanding of quantum physics, followed by a growing focus and investment into technologies that use quantum principles. Quantum technologies [1] are now widely seen as holding the potential to have transformative economic impacts, while offering new tools to address global challenges such as climate change. There are a range of readiness levels across different quantum technologies, but overall quantum is still at an early stage, with most technologies still in the research, development or demonstration phase. The sector is expected to need sustained investment over long-periods of time for the most revolutionary applications to be realised.

New Zealand has a significant quantum research cluster based around Te Whai Ao - The Dodd-Walls Centre (connected to several New Zealand universities), which is involved in world class research at the forefront of quantum and photonic technologies. Research strengths, particularly in the field of photonic technologies (grounded in the physics of light e.g. fibre optics, lasers), are leading to increasing commercial applications. A 2020 study estimated the size of New Zealand's photonics sector to be approximately NZD =1.2 billion, growing at 10% per annum, and employing approximately 2,500 people across 120 companies (e.g. Quantifi Photonics).

Quantum in the United Kingdom

The UK was an early mover on quantum, investing GBP1 billion from 2014-2023 through its National Quantum Technologies Programme, which includes a series of hubs across the country attached to universities and innovation challenges. The programme is credited with contributing to the UK's strong global position in quantum including its third place (after the US and China) in research output on quantum sciences and second place (after the US) in the number of quantum companies and amount of private quantum investment. The Innovate UK Quantum Landscape Map currently lists over 230 quantum businesses in the UK, encompassing quantum technology developers, consultancies, end users, supply chain and innovation network.

[1] "Quantum" refers to an emerging set of technologies that use the principles of quantum mechanics (which usually become apparent at very small length scales). Applications include quantum computing, quantum sensing (e.g. navigation, measuring emissions) and quantum communication (e.g. secure communications). Photonics is a more established field of technology that uses the quantum physics of light. Photonic technologies are part of the componentry or manufacturing process of a range of everyday products such as smart phones or fibre optic cables.

Initial applications from this investment are beginning to emerge. In 2022, BT and Toshiba began the world first commercial deployment of a quantum-secure network between two sites in London. The network demonstrates how Quantum Key Distribution can be used to secure data traffic between key industrial sites where security is of paramount importance. Scientists at the University of Nottingham have developed a wearable quantum enabled brain scanner, which uses lightweight quantum sensors to measure magnetic fields generated by the brain, and is already in use in hospitals in the UK.

The UK government has recognised that the major challenge with quantum technologies will be translating the strength of its research base into commercial success. Overcoming the engineering and scalability challenges required for widespread commercialisation is expected to require significant public and private investment. Another key challenge is the requirement to develop a pipeline of skills. As well as developing this through the UK's education system, the UK will also need to remain attractive to international talent in an increasingly competitive global marketplace, in which demand for skills currently significantly outstrips supply.

National Quantum Strategy

To overcome these challenges, the UK in February 2023 launched a new National Quantum Strategy, underpinned by GBP2.5 billion over ten years. The vision for this strategy is for the UK to be a leading quantum-enabled economy by 2033, with a world leading sector, and where quantum technologies are an integral part of the UK's future digital infrastructure and advanced manufacturing base, driving growth and helping to build a thriving and resilient economy and society. It sets out four goals:

- Ensure the UK is home to world-leading quantum science and engineering
- Support businesses, making the UK the go-to place for quantum businesses and an integral part of the global supply chain
- Drive the adoption and use of quantum technologies in the UK to deliver benefits for the economy and society, as well as the UK's national security
- Create a national and international regulatory framework that supports innovation and the ethical use of quantum technologies, and protects UK capabilities and national security

The strategy was followed in November 2023, by the announcement of five National Quantum Strategy Missions that will guide investment and activity. These are:

- By 2035 there will be accessible, UK-based quantum computers capable of running 1 trillion operations and supporting applications that provide benefits well in excess of classical supercomputers across key sectors of the economy
- By 2035 the UK will have deployed the world's most advanced quantum network at scale, pioneering the future quantum internet

- By 2030 every NHS Trust will benefit from quantum sensing-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment
- By 2030 quantum navigation systems, including clocks, will be deployed on aircraft, providing next-generation accuracy for resilience that is independent of satellite signals.
- By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure in the transport, telecoms, energy and defence sectors.

The missions were developed in close coordination with industry and academia. They are designed to focus on achieving specific, ambitious outcomes that will have wide-ranging spillover benefits.

An international approach

The UK's approach has a strong international orientation, which recognises the need to attract international talent and investment, and the need to be integrated into emerging global supply chains. In addition to taking an open and collaborative approach to research, the UK is forming bilateral partnerships focused on fostering connections between industries, researchers and policy makers. These relationships include growing links between centres of excellence, running exchanges, workshops and summer schools (see further information on partnerships with Singapore, Canada, Australia and the Netherlands).

The UK is also increasingly engaging at the official level on standards, ethics and regulation, including through multilateral groupings such as the 13 country Multilateral Dialogue on Quantum. Every year the UK hosts a National Quantum Technologies Showcase, which draws in international delegations of researchers, officials and investors. Officials from MFAT and MBIE attended the 2023 showcase, which attracted over 1,500 people from 34 countries.

Opportunities for New Zealand

Investments into quantum science and its increasing commercialisation in the UK present opportunities for New Zealand researchers and companies. New Zealand's role in pioneering certain aspects of quantum science, particularly quantum optics, has contributed to a positive New Zealand reputation in quantum science and there are strong people to people links between New Zealand and UK researchers. Institutional relationships such as that between the UK's National Physical Laboratory (NPL) and the New Zealand Measurements Standard Laboratory (MSL) and Dodd-Walls Centre are another important feature of the relationship.

Strengthening research collaboration on quantum has been a priority for New Zealand

officials under the NZ-UK Research Science and Innovation Memorandum of Arrangement signed in 2022. In September 2023, MBIE announced Quantum Technologies Aotearoa, an investment of NZD12 million over five years to support the Dodd-Walls Centre to collaborate internationally on quantum technologies with several named countries, including the UK.

With the recent signing of the NZ-UK Free Trade Agreement, New Zealand businesses will also be well placed to benefit from growing demand for quantum technologies, including photonic technologies, in the UK. A recent UK industry forecast estimated that by 2035 more than 60% of the UK economy will directly depend on photonics to remain competitive. This includes net zero technologies, with solar and wind generation requiring photonic components. The photonics industry in the UK is currently worth approximately GBP15 billion in the UK and growing at an annual rate of 7%.

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