

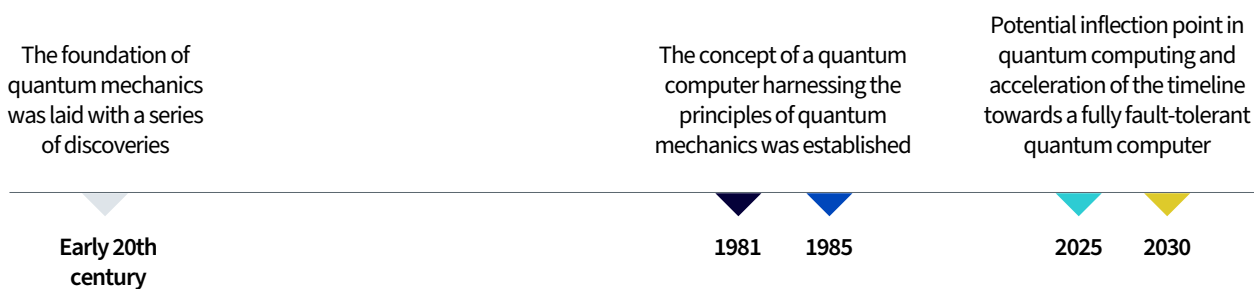
# The case for quantum computing: the next frontier in technological transformation

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Quantum computing is now decisively shifting from foundational research to commercial and practical viability. A series of discoveries in the early 20th century by physicists such as Einstein, Bohr, Heisenberg, and Schrödinger among others, laid the foundation of the quantum paradigm. However, it wasn't until 1980 that Paul Benioff became the first to suggest that operations on classical computers could be modelled using the laws of quantum mechanics, with information processed via quantum bits, or qubits. Unlike classical bits, which can be either 0 or 1, qubits can represent multiple states simultaneously through a property called superposition, allowing quantum computers to explore many calculation paths at once. In 1981, Richard Feynman proposed the concept of a quantum computer, and, in 1985, David Deutsch was the first to formalise its architecture. Deutsch's work laid the groundwork for the concept of quantum advantage, sparking the emergence of quantum computing as a distinct research frontier (Figure 1).

Quantum advantage signifies a meaningful benefit delivered by quantum computers vs classical computers in real-world applications.

Figure 1: Key milestones in quantum computing



Source: WisdomTree, for illustrative purposes only.

## The promise of quantum computing: strategic importance and real-world impact

The peculiar properties of qubits, such as superposition, entanglement, and interference, are at the heart of quantum computing and enable exceptional computational efficiencies and calculations at scales and speeds unattainable by classical computers. The promise of quantum advantage, representing the core value proposition of quantum computers compared to classical counterparts, positions quantum computing as a strategically critical domain for governments and businesses alike.

As a result, quantum computing's potential to solve previously intractable challenges in cryptography, drug discovery, materials science, climate modelling, and other areas involving very complex computational and optimisation tasks has attracted billions of dollars in global investment. Extensive strategic funding from leading tech corporations, innovative startups, and governments worldwide underscores growing confidence in quantum computing's ability to deliver tangible, real-world impact. McKinsey & Co estimates that in the next 5 to 10 years quantum computing will deliver significant economic value across several domains, such as finance, pharmaceuticals, energy and materials, transport, and logistics, with the aggregate value at stake amounting to \$1tn - \$2tn (Figure 2).

Figure 2: Estimated economic value of quantum computing across selected domains in the next 5 to 10 years

Key segment for quantum computing	Economic value		2035 market size, \$ trillion	Value at stake with incremental impact of quantum computing by 2035, \$ billion	
	~2025-2030	~2030-2035			
Financial services*	++	+++	14.1	400-600	
Sustainable energy**	+	+++			
Chemicals	++	+++	6.1	200-500	
Travel, transport, and logistics	+	+++	14.1	200-500	
Pharmaceuticals	++	+++	3.1	70-400	
Automotive	+	++	8.3	50-100	

Economic value:	+	Low
	++	Medium
	+++	High

Source: McKinsey & Co, “Quantum Technology Monitor”, April 2024. **Forecasts are not an indicator of future performance and any investments are subject to risks and uncertainties.**

\*Quantum computing technology is immature and has high uncertainty for viability and value of use cases. Business-value estimates are preliminary and intended to guide research toward high-value-potential areas, not as definitive projections for business value. Insurance is not included.

\*\*The sustainable energy market is expected to grow rapidly from 2022–2035; however, the 2035 market size is influenced by numerous factors and challenging to predict.

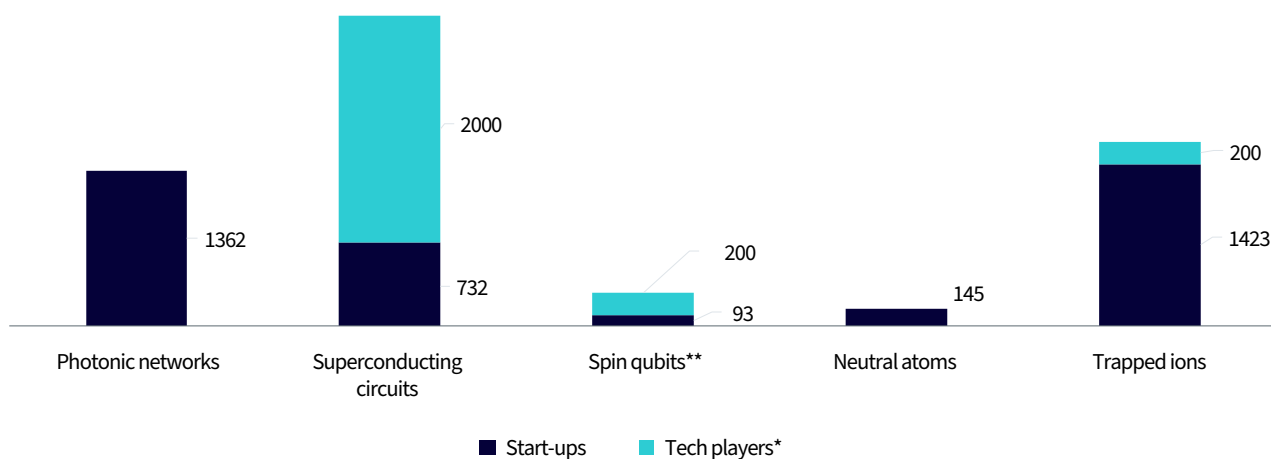
## Industry use cases

Most quantum computing use cases revolve around the field’s dramatic reduction in time required for executing optimisation, factorisation, simulation, and other very complex computational algorithmic processes that makes a range of problems solvable in contrast to classical computers. Thus, the goal of quantum computing, set to unlock its key value proposition, is to build a fully fault-tolerant quantum computer that will enable the field to deliver a quantum advantage across numerous use cases.

There is no one way to get to this milestone, as multiple quantum computing hardware architectures, or qubit technologies, are currently under development, and breakthroughs in any of them can shorten the timeline to viability (Figure 3). As the quantum computing hardware matures in the coming years, many more viable use cases can emerge globally. But even before that milestone is achieved quantum computers can already be used to deliver value.

A universal quantum computer will most likely be a gate-based system, but annealer-based<sup>1</sup> systems represent an important frontier and have specific practical use cases already. Example applications with digital annealers include credit scoring, portfolio optimisation, dynamic pricing, logistics and routing, and molecular search.

Figure 3: Funding in main qubit technologies underpinning currently developed quantum computers (\$ million)



Source: McKinsey & Co, “What is quantum computing?” published on 31 March 2025, using Capital IQ, Crunchbase, Pitchbook, McKinsey analysis. **Historical performance is not an indication of future performance and any investments may go down in value.**

\*Assumptions: \$500 million per major player (Google, IBM, Alibaba, AWS) and \$200 million per medium player (Honeywell before merger with QQC into Quantinuum, Intel).

\*\*Electron spins in silicon quantum dots are examined here because other spin qubits are generally not considered for applications in quantum computing.

Quantum computing’s further potential to revolutionise a range of industries, can be demonstrated with a few powerful examples:

**Drug discovery:** quantum computing has the potential to dramatically accelerate and refine drug discovery by enabling faster, more precise target identification, molecular design, and toxicity testing, reducing reliance on trial and error. This could significantly shorten research and development (R&D) timelines, lower costs, and ultimately deliver life-saving treatments to patients faster and more efficiently.

**Chemistry and climate change:** quantum computing can simulate complex molecular and chemical interactions with unprecedented accuracy, enabling researchers to model and optimise new materials and reactions at the atomic level. This capability opens the door to breakthrough innovations in carbon capture, next-generation fuels, high-efficiency batteries, sustainable

1 Digital annealers represent quantum-inspired computing systems specifically useful in solving large-scale optimisation problems, where performance of classical computers is limited due to a problem’s complexity. Digital annealers provide a practical bridge between today’s classical computers and future quantum computing systems.

fertilisers, and advanced catalysts—accelerating the discovery of cleaner, more efficient technologies critical for addressing climate change.

**Finance:** in finance, quantum computing can deliver one of the largest economic value creations estimated to reach around \$622 billion<sup>2</sup>. One of the impact areas among others include optimisation of portfolios and pricing models, collateral and lending decisions, quantum-safe encryption through post-quantum cryptography (PQC) and quantum key distribution (QKD), risk scenario analysis, fraud detection, and highly personalised portfolio strategies.

## Quantum computing's inflection point

With quantum processors demonstrating significant advancements in performance and reliability, the global quantum computing landscape is confidently progressing toward achieving quantum advantage, bringing practical quantum technologies ever closer to commercial viability. A convergence of key technological breakthroughs, intensifying quantum computing activities, substantial increases in public and private funding, rising global awareness, the anticipation of Q Day<sup>3</sup>, an expansion of the talent pool, and, notably, the nexus between quantum computing and artificial intelligence (AI) collectively signal that quantum computing may be nearing an inflection point.

“Quantum computing is reaching an inflection point”  
– Jensen Huang at NVIDIA GTC 2025

## Technological breakthroughs

The promise of quantum computing critically hinges on sustained breakthroughs within the field. Recently, several prominent companies active in quantum computing have demonstrated tangible progress across key areas such as qubit technology, error-correction algorithms, and hardware stability. Google's unveiling of its quantum processor, Willow (Sycamore), Amazon's introduction of its Ocelot quantum processor, and Microsoft's advances in topological qubits and Majorana 1 chip, collectively illustrate important progress in the field and suggest more optimistic timelines for practical quantum applications. IBM, a leading industry player, recently announced plans to build Starling, a large-scale, fault-tolerant quantum computer expected

2 McKinsey & Company estimates provided in “Quantum technology use cases as fuel for value in finance” published in October 2023. Estimates assume that 50% of the full potential in the finance industry will be realised by 2035.

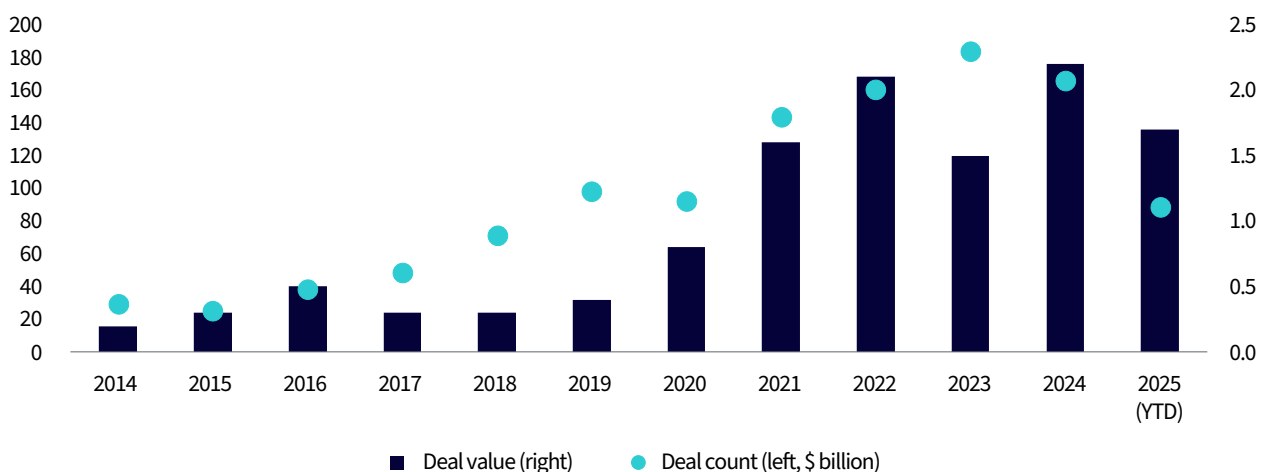
3 ‘Q Day’ refers to the moment when quantum computers become powerful enough to break widely used public-key encryption systems.

by 2028, underscoring growing confidence in the sector’s trajectory toward viable real-world quantum solutions.

### A surge in quantum computing activities and investor confidence

Major technology providers such as Amazon, Google, IBM, and Microsoft have increasingly offered accessible cloud-based quantum computing services, broadening the user base and accelerating quantum research and experimentation across industries. At the same time, strategic partnerships between quantum startups, industry leaders, and academic institutions are fostering cross-disciplinary innovation, rapidly advancing technological breakthroughs, and shortening timelines to market readiness. High-performance computing (HPC) centres worldwide are being upgraded to accommodate quantum computing infrastructure, creating a supportive ecosystem crucial for the practical deployment and scalability of quantum technologies. Increasing venture capital activity and growing investment into quantum startups (Figure 4) reflect rising investor confidence in the field's transformative impact and potential for future returns, while government initiatives across the globe further amplify these dynamics.

Figure 4: Venture capital funding in quantum computing companies



Source: PitchBook News, as of 12 June 2025. Historical performance is not an indication of future performance and any investments may go down in value.

### Public funding and increased awareness

Governments worldwide are significantly increasing their investments in quantum technologies, funding substantial quantum research projects, establishing national quantum programs, and encouraging collaboration between private and public sectors. The latest estimates suggest total public funding at approximately \$42 billion (Figure 5). This level of financial commitment underscores governmental recognition of quantum computing's transformative potential to advance national security, economic competitiveness, and technological innovation.

Moreover, heightened global awareness is acting as another powerful tailwind, amplified by initiatives such as the United Nations General Assembly's declaration of 2025 as the International Year of Quantum Science and Technology. This milestone marks 100 years of quantum science, aiming not only to celebrate past achievements but also to drive greater public engagement, foster international collaboration, and stimulate educational programs and workforce development in quantum technologies.

Figure 5: Announced government investment<sup>4</sup> in quantum computing (\$ billion, not exhaustive)



Source: McKinsey & Co, “Quantum Technology Monitor”, April 2024. Historical performance is not an indication of future performance and any investments may go down in value.

### The expectation of Q Day

The expectation of Q Day, a critical future moment when quantum computers will become capable of breaking widely used encryption methods such as RSA and ECC<sup>5</sup>, highlights the profound computational power of future quantum machines and associated risks. This anticipated event has significant implications for cybersecurity, prompting increased urgency among businesses, governments, and technology providers to develop quantum-resistant cryptographic solutions. The anticipation of Q Day significantly enhances awareness and accelerates efforts toward quantum readiness, galvanising strategic preparations across various industries.

### Talent development

As quantum technology rapidly advances, the demand for skilled professionals significantly outpaces the available talent pool. To address this gap, universities and educational institutions worldwide are increasingly expanding their academic offerings in quantum information science and related fields, underscoring the growing importance of the field and confidence in its

<sup>4</sup> Total historic announced investment. timelines for investment vary by country.

<sup>5</sup> RCA refers to Rivest-Shamir-Adleman encryption method and ECC refers to Elliptic Curve Cryptography method.

continued development. Reflecting this response, in 2023 alone, there were 195 quantum research programs and 55 dedicated master's degree programs available globally<sup>6</sup>. These increasing efforts to develop the next generation of quantum talent are vital for sustaining growth and advancing the quantum computing field.

### **The nexus of quantum computing and AI**

The intersection between quantum computing and AI represents a powerful synergy, significantly amplifying the transformative potential of both technologies. Quantum computing promises to accelerate AI advancements dramatically by substantially increasing computational power, efficiently processing massive datasets, and enhancing training and learning capabilities. Such quantum-enabled improvements could catalyse major breakthroughs in AI, potentially bringing humanity closer to realising artificial general intelligence.

Conversely, AI technologies actively address critical quantum computing challenges. AI-driven approaches in quantum error correction, noise mitigation, and algorithm optimisation enhance quantum hardware reliability and computational efficiency. Additionally, AI facilitates advanced simulations and emulations of quantum systems, which are crucial for algorithm development and quantum research. This interplay between AI and quantum computing creates a mutually reinforcing cycle, further driving quantum computing's swift progress toward commercial viability and practical application.

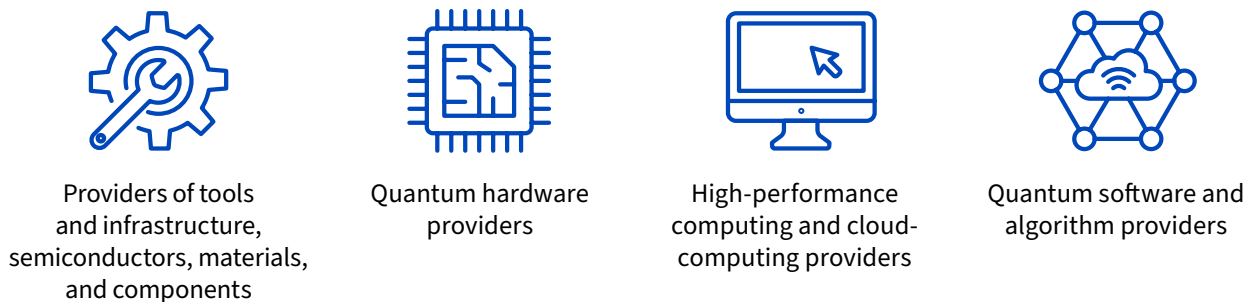
### **Capturing the investment potential of quantum computing**

As breakthroughs in the field gather momentum, industry engagement expands and both public and private funding steps up, investors now have an opportunity to engage with this transformative technology in its early innings.

The quantum computing ecosystem currently comprises diverse players, ranging from infrastructure, tools, and component suppliers to hardware developers, high-performance computing (HPC) and cloud-computing providers, software and quantum algorithm developers, research institutions, and specialised consulting firms. Gaining early exposure to companies driving the development and adoption of quantum computing represents a compelling strategy for capturing the technology's growth potential. Investing across the breadth of quantum computing opportunities is particularly important, as the evolution of this theme will occur in stages, with different ecosystem segments benefiting at varying times, offering investors a diversified and attractive combination of return streams (Figure 6).

<sup>6</sup> Source: McKinsey & Co, "Quantum Technology Monitor", April 2024.

Figure 6: Major players in the quantum computing ecosystem



Source: WisdomTree, for illustrative purposes only.

Currently, while only a few pure-play quantum computing companies are publicly traded, the quantum ecosystem is vibrant and diverse, comprising hundreds of pure-play innovative private companies as well as more diversified publicly traded companies actively advancing the field. The limited availability of publicly listed pure-play firms today presents investors with a timely opportunity to engage early, positioning themselves strategically ahead of broader market recognition and increased public listings. Several compelling reasons underline why now is an exciting moment to explore and invest in the quantum computing space.



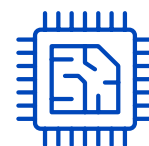
#### Transition from private to public markets

With continued breakthroughs and growing investor interest, more quantum-focused companies will inevitably transition from private to public markets, expanding the available investment opportunities. Early participation allows investors to closely monitor developments and gain exposure to prominent companies as they become publicly listed.



#### Investments from large, diversified players

Many large, diversified companies across various industries are actively investing in quantum computing research and developing quantum-based solutions to secure competitive advantages. Alongside pure-play companies, these industry leaders, such as tech giants, play a pivotal role in advancing quantum computing due to their substantial financial and technological resources. Growing enthusiasm around quantum computing suggests that share prices of these companies are bound to reflect investor excitement surrounding significant milestones in their respective quantum efforts.



#### Growth through enabling players

Companies supplying infrastructure, tools, components, and specialised materials provide essential building blocks crucial for the development and scaling of quantum technologies. A range of these enabling companies are publicly traded and also serve adjacent, high-growth technology sectors such as AI. Leveraging

demand from AI, these firms stand to gain from reinforcing technological and commercial synergies between the two fields, creating additional growth opportunities for investors.



### **Capitalisation on quantum readiness**

Increasing awareness around quantum computers' future potential to compromise existing cryptographic standards (Q Day) is already driving demand for quantum-secure encryption and post-quantum cryptographic solutions. Companies active in post-quantum cryptography, quantum communications, and quantum networking form integral components of the quantum ecosystem. These companies offer attractive investment opportunities well before widespread commercialisation of fully fault-tolerant quantum computers, enabling investors to benefit from early-stage market growth driven by the urgency for quantum readiness.



### **Growth potential and volatility**

As quantum computing is in its emerging stage, the share price volatility of pure-play companies is quite high, with heightened enthusiasm around industry and company specific announcements on the upside and high sensitivity to broad risk-off market sentiment on the downside. In this stage of the quantum computing market, investors may benefit from balancing exposure to pure-play quantum computing companies, offering high growth potential, with more diversified companies, which provide stability. A diversified approach investing across the breadth of quantum computing ecosystem, combining a basket of pure-play quantum stocks with diversified firms committed to quantum computing and driving the advances in the field, offers a robust strategy for capturing future growth in quantum technologies while managing risk effectively.

## **Conclusion**

Quantum computing represents one of the most transformative technological themes currently emerging, with the potential to reshape numerous industries profoundly. By proactively engaging with and understanding this revolutionary technological frontier, investors can strategically position themselves to capture substantial value as quantum technologies mature. Early participation not only allows investors to benefit from growth across the diverse quantum ecosystem but also offers the chance to influence and shape the trajectory of quantum computing as it becomes increasingly integral to future technological and economic advancement.

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