KQUANTA RESEARCH

Mid-Year Review

Potential to Practice: Quantum Tech & AI

2025

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THE 2025 INTERNATIONAL YEAR OF QUANTUM SCIENCE AND TECHNOLOGY (IYQ) RECOGNIZES 100 YEARS SINCE THE INITIAL DEVELOPMENT OF QUANTUM MECHANICS.

INTERNATIONAL YEAR OF
Quantum Science
and Technology

1. Executive Summary

Six months after our inaugural analysis, ***'Unleashing the Potential of Quantum Technology and AI in Financial Services – Shaping Tomorrow Today,'*** the quantum technology landscape is gradually evolving, with the field beginning to transition from research and pilot programmes towards the initial stages of real-world adoption. While much of the sector remains anchored in experimentation, early practical applications are now emerging across financial services, climate and sustainability, and supply chain management.

Purpose of This Report

This follow-up report aims to raise awareness among decision makers and business leaders about the measured but accelerating progress of quantum technology and artificial intelligence. Building on the foundations of our original report, it provides a balanced update on investment trends, policy developments, and commercial advances, equipping stakeholders with the insights needed to make informed strategic decisions and prepare their organisations for the quantum era.

Investment Momentum

Quantum technology funding has seen notable growth, with over $1.25 billion raised in Q1 2025—a 125% year-on-year increase—driven by major rounds for companies such as IonQ, QuEra, and Quantum Machines. Commercial orders for quantum computers reached $854 million in 2024, and the first multi-year, full-stack system contracts are signalling a cautious but clear shift from experimentation to operational deployment in finance, logistics, and materials science.

Policy and Regulation

Governments are responding with significant national strategies and funding packages. The UK, Spain, Japan, and South Korea have all announced major initiatives, while the UK's National Cyber Security Centre has set a 2035 deadline for post-quantum cryptography migration, highlighting the growing importance of quantum-safe security planning.

Commercial Transition

The sector is moving beyond the experimental phase. Quantum computing companies generated between $650–750 million in revenue in 2024, reflecting increasing confidence in commercial viability. Market valuations are forecast to rise from $5.6 billion today to $97 billion by 2035, marking a gradual but significant shift towards mainstream quantum adoption.

Technological Convergence

The convergence of quantum computing and artificial intelligence is emerging as a key technological development. Hybrid quantum-classical systems are beginning to deliver practical benefits in financial services, climate modelling, and logistics optimisation, with early real-world implementations now complementing laboratory demonstrations.

Skills and Workforce

This expansion has brought about a pronounced skills gap. Demand for quantum expertise now far exceeds the supply of traditionally trained physicists and engineers, making workforce development a growing constraint on sector progress.

Market Outlook

Recent analysis indicates the global quantum computing market reached $0.3 billion in 2024 and is projected to reach $6.3 billion by 2032, representing a 46.5% CAGR. Private and public investment approached $2 billion in 2024, and quantum computing revenues are expected to surpass $1 billion in 2025.

Highlighted Use Cases

- **Financial Services:** Quantum is supporting advances in portfolio optimisation, derivatives pricing, risk management, trading, and fraud detection, with leading banks running live pilots and proofs of concept.
- **Climate and Sustainability:** Quantum computing is accelerating material discovery, improving climate modelling, and optimising energy systems for greater efficiency and lower emissions.
- **Supply Chain:** Companies are using quantum algorithms to optimise logistics, reduce delivery times and costs, and manage inventory and carbon footprints more effectively.

Conclusion

The pace of technological progress and the breadth of enterprise experimentation underscore the need for decision makers and business leaders to remain attentive and proactive. Quantum technologies are beginning to reshape risk, security, and value creation across industries. Early engagement and strategic preparation will be essential for capturing the opportunities of this emerging era. This report builds on the insights of our original analysis to provide a timely, measured update for those shaping tomorrow's business strategies today.

2. Quantum Technology Applications - From Theory to Commercial

i. Understanding Quantum Technology: A Business Perspective

Before exploring the business implications, it's essential to understand what quantum technology actually is and how it differs from classical computing. At its core, quantum computing harnesses the strange behaviour of particles at the atomic level to process information in fundamentally different ways than traditional computers.

Classical Computing vs Quantum Computing: A Simple Analogy

Think of classical computing like a library with millions of books. To find the answer to a question, you must search through the books one by one, or at best, several at once with multiple librarians. No matter how fast your librarians work, you are still limited by having to check each book sequentially.

Quantum computing is like having a magical library where you can ask your question and have all the books simultaneously whisper their answers, with the correct answer emerging from the collective response. This is possible because quantum bits (qubits) can exist in multiple states simultaneously, unlike classical bits that are either 0 or 1.

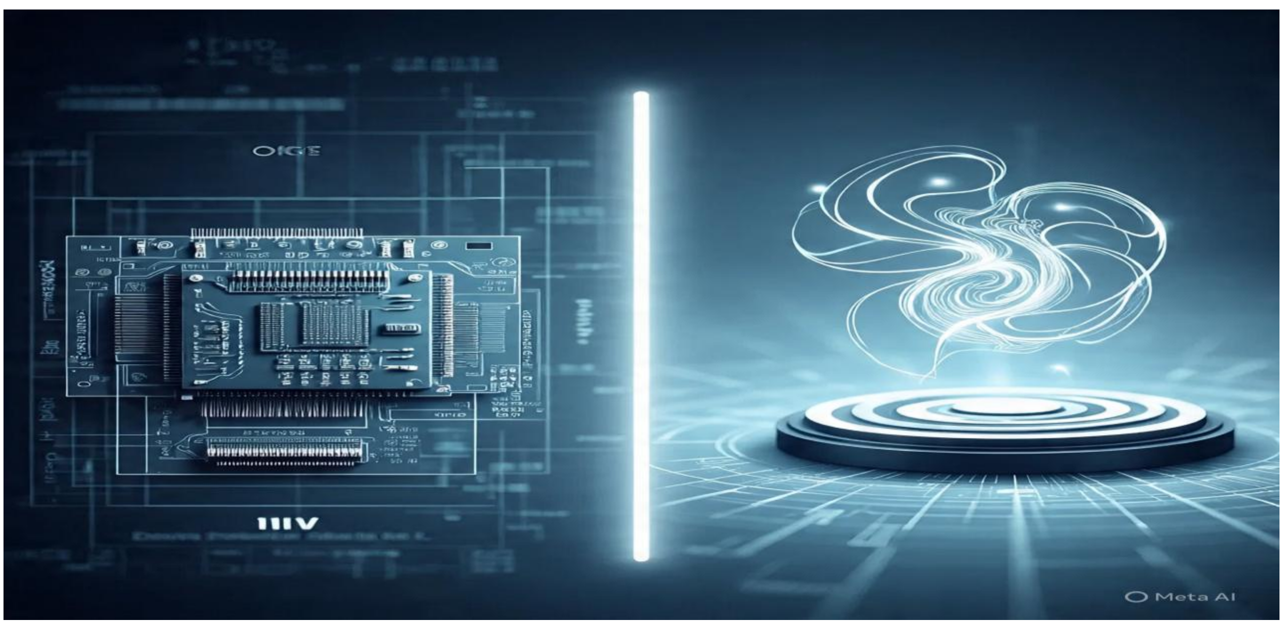
Source: Meta Ai

Three Quantum Technology Pillars

- **Quantum Computing** harnesses quantum bits (qubits) that exist in multiple states simultaneously, enabling parallel processing of countless scenarios. This provides exponential performance improvements through superposition, entanglement, and quantum interference.
- **Quantum Communication** creates theoretically unbreakable encryption. Quantum Key Distribution (QKD) makes eavesdropping detectable, addressing the "harvest now, decrypt later" threat.
- **Quantum Sensing** provides measurements orders of magnitude more sensitive than classical sensors, detecting minute variations beyond conventional capabilities.

Real-World Examples of Quantum vs Classical Computing

- Consider a travelling salesman who needs to visit 50 cities and find the shortest route. A classical computer would need to calculate millions of possible routes sequentially—potentially taking years for complex problems. A quantum computer can explore many routes simultaneously, finding the optimal solution in minutes or hours.
- In financial portfolio optimisation, classical computers might evaluate thousands of investment combinations one by one. Quantum computers can assess multiple combinations simultaneously, considering complex market correlations and risk factors that would overwhelm traditional systems.



Source: Meta Ai

ii. The Quantum-AI Relationship: A Powerful Partnership

The relationship between quantum computing and artificial intelligence is symbiotic and transformative.

- Classical AI systems are limited by the computational power available to process data and train models.
- Quantum computing offers the potential to accelerate specific AI tasks exponentially.

For instance, machine learning algorithms typically require processing vast datasets to identify patterns. Classical computers must process this data sequentially, which can take weeks or months for complex models. Quantum computers can potentially process multiple data patterns simultaneously, reducing training time from months to days or hours.

Conversely, AI helps quantum computers become more practical. Machine learning algorithms can predict and correct quantum errors, optimise quantum circuits, and determine when quantum approaches offer advantages over classical methods. This partnership creates a feedback loop where each technology enhances the other's capabilities.

Source:Meta Ai

Simple Business Applications

Consider a bank trying to detect fraudulent transactions. Classical systems examine each transaction against known fraud patterns sequentially. A quantum-enhanced system could simultaneously compare transactions against multiple fraud patterns, considering complex relationships between different transaction characteristics that classical systems might miss.

In supply chain management, classical systems optimise delivery routes by testing different combinations sequentially. Quantum systems can explore multiple routing options simultaneously, considering realtime traffic, weather conditions, fuel costs, and delivery priorities all at once.

Business Drivers for Quantum Adoption

Opportunities

The urgency of quantum adoption stems from multiple business imperatives. Competitive advantage is increasingly tied to optimisation capabilities, whether in financial portfolio management, supply chain logistics, or resource allocation.

Quantum algorithms can explore solution spaces more efficiently than classical methods, providing significant advantages in complex optimisation problems that define modern business operations. The sustainability mandate has created additional pressure for quantum adoption, as organisations seek to reduce their carbon footprint whilst maintaining operational efficiency.

Quantum algorithms can optimise energy consumption, reduce waste, and improve resource utilisation across multiple business processes. In an era where environmental, social, and governance (ESG) considerations increasingly influence business decisions, quantum technologies offer measurable improvements in sustainability metrics.

Risk management

Risk management has become another critical driver, as organisations recognise that quantum computers will eventually break current encryption standards. The *"harvest now, decrypt later"* attacks are already occurring, where adversaries collect encrypted data with the intention of decrypting it once quantum computers become available. This threat requires immediate attention to quantum-safe cryptography, making quantum literacy a cybersecurity imperative.

Quantum computing poses significant cybersecurity risks. NIST's post-quantum cryptography standards provide quantum-resistant security frameworks, with 86% of financial institutions remaining unprepared for quantum threats.

The UK's National Cyber Security Centre established a 2035 timeline for post-quantum cryptography migration, whilst the EU has issued a coordinated roadmap for post-quantum cryptography transition.

Canada published its Government migration roadmap in May 2024, with active PQC programmes now running in Germany, Netherlands, France, Australia, Norway, New Zealand, and Japan. China has launched its own quantum-resistant encryption standards, diverging from US-led efforts.

'**Y2Q' (Years to Quantum)** marks the countdown to when quantum machines will break today's encryption, signalling a capability-driven inflection that demands business planning now, unlike the date-focused Y2K.

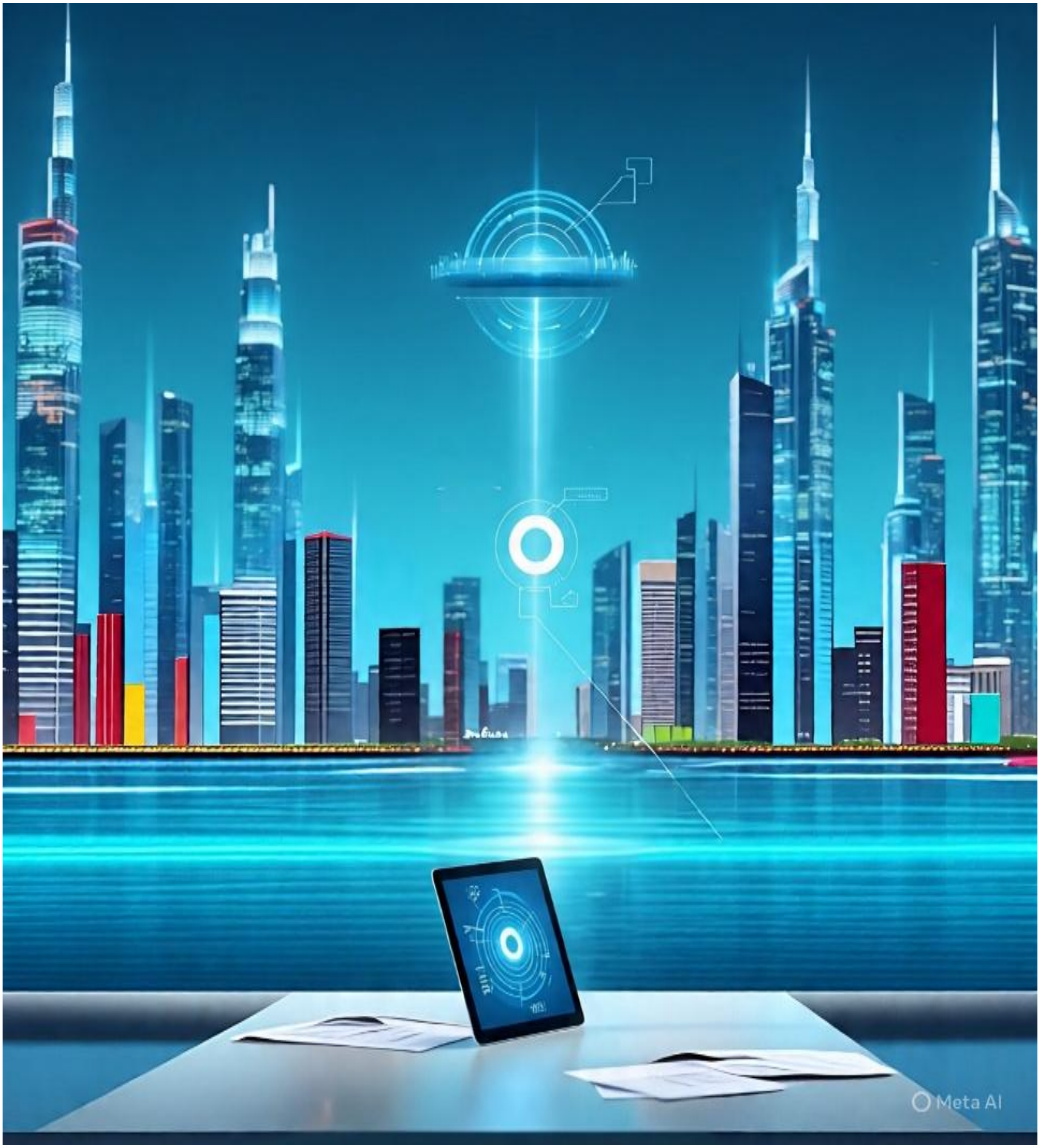
The Y2Q framework urges proactive preparation across applications: optimisation gains are already tangible, and quantum simulation for chemistry and materials is emerging. While cryptographically relevant quantum computing lies ahead, transitioning to quantum-safe systems must start immediately.

The post-quantum cryptography market's surge—from USD 1.22 billion in 2024 to USD 29.95 billion by 2034—underscores the urgency of quantum readiness.

Market Momentum and Commercial Viability

The quantum technology market has reached a critical mass that makes commercial adoption both feasible and necessary. The $1.25 billion in investment during Q1 2025 represents more than just venture capital enthusiasm; it reflects the recognition that quantum technologies are transitioning from research projects to commercial products. This investment surge has accelerated quantum technology development and reduced the barriers to business adoption.

The emergence of quantum-as-a-service models has particularly important implications for business adoption. Rather than requiring significant capital investment in quantum hardware, businesses can access quantum capabilities through cloud services, enabling experimentation and gradual integration without substantial upfront costs. This model has proven particularly attractive to financial services and logistics companies seeking to explore quantum advantages without committing to specific quantum hardware platforms.



Source:Meta Ai

3. Key Developments Since January 2025

Investment Surge

- **Record Q1 2025 Investment:** $1.25 billion in quantum technology investments - a 125% increase from Q1 2024
- **Global Government Commitment:** Total announced government investment reached $55.7 billion globally
- **Private Sector Acceleration:** Major funding rounds including QuEra Computing ($230 million), IonQ ($360 million), and Quantum Machines ($170 million)

Regulatory Breakthroughs

- **NIST Standards Adoption:** Post-quantum cryptography algorithms (CRYSTALS-Kyber, CRYSTALS-Dilithium, SPHINCS+) established as Federal Information Processing Standards
- **EU PQC Mandate:** Comprehensive implementation roadmap announced June 23, 2025, with *mandatory timelines* for quantum-resistant security transitions
- **UK National Strategy:** £670 million investment announced June 30, 2025, providing 10-year funding certainty to NQCC

Technology Maturation

- **Microsoft Majorana 1 Chip:** Breakthrough in topological quantum computing
- **D-Wave Quantum Supremacy:** Demonstrated advantage in materials simulation
- **Quantum-AI Convergence:** Multiverse Computing achieved 60% parameter reduction with 84% greater energy efficiency

Market Acceleration

- **Post-Quantum Cryptography Market:** The global post-quantum cryptography market is projected to grow from $1.22 billion in 2024 to $29.95 billion by 2034 at a 37.72% CAGR, driven by quantum computing advances and security concerns[1]
- **Quantum Computing Transition:** McKinsey confirms shift from qubit quantity to qubit stability focus
- **Commercial Deployment:** Multiple institutions moving from research to production testing phases

[1] https://www.precedenceresearch.com/post-quantum-cryptography-market

Global Investment Landscape

Country/Region	Total Investment (US$ Billions)	Focus Areas	Key Highlights
China	152.60	Communication, sensing, computing, AI	$138B National Venture Capital Guidance Fund
United States	8.30	Computing, cybersecurity, defence	$625M DOE QIS Research Centers funding
Japan	7.00	Computing, communication networks	¥1.05 trillion for next-gen chip research
European Union	5.60	Coordinated research, industry collaboration	€1B Quantum Technologies Flagship
Germany	3.30	Applications, industry integration	€2B national quantum initiative
France	2.20	Computing, communication, security	National quantum plan implementation
United Kingdom	0.87	Financial security, computing applications	£670M June 2025 commitment
India	0.74	Computing, communication, sensing, materials	₹6,003 crore National Quantum Mission

Source:Meta Ai

Technology Convergence Breakthroughs

i. Quantum-AI Integration

2025 has witnessed the practical convergence of AI and quantum technologies, with companies like Multiverse Computing releasing quantum-inspired AI models that achieve:

- 60% parameter reduction
- 84% greater energy efficiency
- 40% faster inference while maintaining accuracy

This convergence represents the realisation of *Quantum AI (QAI)* as a commercially viable technology stack.

Critical Security Imperatives

ii. Post-Quantum Cryptography Implementation

The establishment of NIST's post-quantum cryptography standards has created immediate implementation imperatives for financial institutions. The three standardised algorithms provide quantum-resistant security frameworks that address the "harvest now, decrypt later" threat, where adversaries collect encrypted data today for future quantum decryption.

Key Security Challenges:

- 86% of financial institutions remain unprepared for quantum threats
- EU mandate establishes mandatory timelines for quantum-resistant security transitions
- UK's National Cyber Security Centre established 2035 timeline for PQC migration

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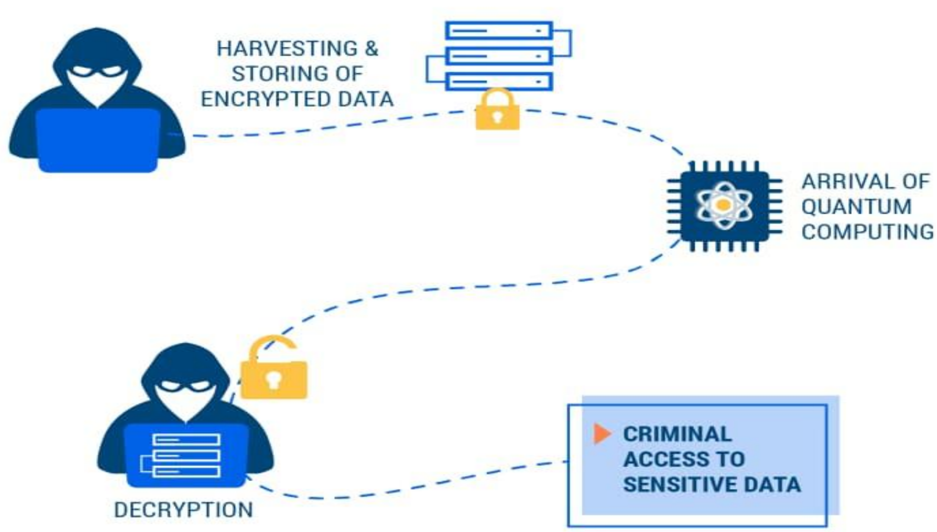


4. Sector-Wise Use Case Analysis: Financial Services, Climate, Logistics

Financial Services Applications

Organisation	Target Application	Quantum/AI Technique	Performance Benefit
HSBC +RIGETTI +UK+ NQCC[2]	Card fraud & AML anomaly detection	Quantum Support Vector Classifier & hybrid Boltzman models	Improved Accuracy & Enhanced detection speed
GOLDMAN SACHS + QC WARE + IBM[3]	Multi asset portfolio optimisation & derivatives pricing	Monte Carlo & Quantum Approximate Optimization Algorithm (QAOA) hybrids	Monte Carlo replacement capability, reducing computational time
JP MORGAN CHASE [4]+ARGONNE NATIONAL LABORATORY + QUANTINUUM	Solving complex Optimisation problems	Quantum machine learning & Quantum reinforcement learning	Improved optimisation
BNP PARIBAS ASSET MANAGEMENT [5]+QUANTUMSTREET AI	Cross-asset trend and AI index in Brazil with global plans	AI-driven signals enhanced by quantum - inspired ML	Enhanced investment strategies
WELLS FARGO + IBM[6] QUANTUM NETWORK	AI-quantum integration for banking optimisation	Hybrid quantum-classical workflows	Faster, safer banking services

[2] https://www.insidequantumtechnology.com/news-archive/uk-grant-helps-rigetti-hsbc-group-apply-quantum-machine-learning-to-detect-money-laundering/

[3] https://www.marketscreener.com/quote/stock/THE-GOLDMAN-SACHS-GROUP-I-12831/news/Goldman-Sachs-and-QC-Ware-Collaboration-Brings-New-Way-to-Price-Risky-Assets-within-Reach-of-Quantum-33416065/

[4] https://www.jpmorgan.com/technology/news/jpmorganchase-research-collaboration-shows-quantum-algorithm-speedup

[5] https://usa.bnpparibas/en/bnp-paribas-collaborates-with-quantumstreet-ai-to-launch-cross-asset-trend-and-ai-index-in-brazil/

[6] https://www.insidequantumtechnology.com/news-archive/ibm-wells-fargo-to-collaborate-on-ai-quantum-computing/

Climate and Sustainability Applications

Organisation	Sustainability Use case	Quantum/AI Technique	Implementation Status	Performance Benefit
E. ON + D-WAVE[7]	Renewable grid micro-grid portioning	Quantum annealing community detection	Real-time IEEE-118 bus system deployment	Stability & efficiency improvements
QUANTYMIZE +ENERGY PARTNERS[8]	Battery energy management optimisation	Quantum annealers with QUBO formulations	Commercial deployment	40% reduction incharge -discharge cycles
TOTAL ENERGIES[9] QUANTINUUM	Carbon capture materials discovery Metal-Organic Frameworks (MOF)	Quantum Chemistry simulations	Advanced Research phase	Quantum Chemistry simulations can help design optimised MOFs for efficient carbon capture, potentially reducing CO2 emissions
CORNELL UNIVERSITY + DATA CENTERS[10]	Reduce energy consumption in large data centres handing AI workload	Quantum based optimisation frameworks	Proof of concept complete	12.5% energy reduction ,9.8% carbon emission cuts

7 https://www.dwavequantum.com/media/mjygj2qe/dwave_eon_case_study_v5-1.p

8 https://thequantuminsider.com/2025/01/20/quantymize-adding-quantum-power-to-energy-management/

9 https://thequantuminsider.com/2022/04/11/quantinuum-and-totalenergies-investigate-using-quantum-computers-to-study-carbon-capture/

10 https://thequantuminsider.com/2024/06/03/quantum-ai-framework-targets-energy-intensive-data-centers/#:~:text=Cornell%20researchers%20designed%20a%20quantum-based%20optimization%20framework%20that,their%20carbon%20emissions%20by%20as%20much%20as%209.8%25.

Supply in and Logistics Applications

Organisation	Optimisation Focus	Quantum/AI Technique	Implementation Status	Performance Benefit
D-WAVE [11]+MOMENTUM WORLDWIDE	Vehicle routing last-mile delivery, emergency response and fleet operations	Hybrid quantum annealing (5000+qubits)	Active deployment demonstrating results	Fuel/time reduction in benchmark routes
SAVANTX + FENIX MARINE +D-WAVE+PORT OF LOS ANGELES[12]	Port terminal crane & container scheduling	HONE (Hyper Optimisation Nodal Efficiency) is a quantum-powered AI engine developed by SavantX, leveraging quantum computing technology from D-Wave to tackle large-scale optimisation problems in supply chain management	Operation at LA Pier 300	Double cargo handling equipment productivity
VOLKSWAGEN[13] + QUTAC	Automotive factory -the paint shop	New algorithm powered by Quantum computing	Research and pilot phase	Enhanced supply chain efficiency
ProvideQ [14]Consortium (Germany)	SME Logistics scheduling tool box	QAOA &CQM solver demonstration	Open-source toolkit released March 2025	Accessible Quantum tools for industry

[11] https://www.dwavequantum.com/media/t5be11b4/logistics-routing-data-sheet.pdf

[12] https://thequantuminsider.com/2022/01/08/savantx-d-wave-collaborate-on-quantum-algorithms-to-tackle-supply-chain-problems-at-u-s-s-busiest-port/

[13] https://www.qutac.de/en/volkswagen-effizientere-auto-lackieranlagen/

[14] https://www.digitale-technologien.de/DT/Redaktion/EN/Kurzmeldungen/Aktuelles/2025/QC/250610_provideQ_logistikbranche.html

5. Strategic Recommendations

Immediate Action Requirements

1. Accelerate PQC Implementation

Financial institutions must prioritise post-quantum cryptography deployment given the 86% unpreparedness rate. The *"harvest now, decrypt later"* threat requires immediate action.

Key Actions:

- Conduct encryption infrastructure audits to identify quantum-vulnerable systems
- Develop phased migration plans using NIST's standardised algorithms
- Align with UK's 2035 deadline and EU PQC mandate timelines
- Engage in sector-wide collaboration to share implementation costs

2. Develop Collaborative Ecosystems

Follow Germany's ProvideQ[15] model funded by the German Federal Ministry for Economic Affairs and Energy for successful public-private partnerships that accelerate adoption whilst sharing costs and risks.

Ecosystem Framework:

- Join industry-specific quantum consortiums
- Establish academic partnerships for research and talent development
- Participate in national quantum strategies and funding programmes
- Engage cross-sector learning to identify transferable solutions

3. Strategic Positioning

Organisations investing now gain significant competitive advantages as technology matures, with first-mover benefits becoming increasingly difficult to replicate.

Positioning Strategy:

- Build internal quantum expertise to reduce external dependence
- Establish quantum technology monitoring systems
- Develop client quantum literacy programmes
- Assess supplier network quantum readiness

[15] https://www.digitale-technologien.de/DT/Redaktion/EN/Kurzmeldungen/Aktuelles/2025/QC/250610_provideQ_logistikbranche.html

6. Conclusion

The quantum technology and artificial intelligence landscape has fundamentally shifted from theoretical promise to commercial reality in 2025. This mid-year assessment reveals a sector experiencing unprecedented momentum, driven by record investment levels, regulatory standardisation, and measurable performance improvements across critical business applications.

The Transformation is Already Underway

The $1.25 billion Q1 2025 investment surge represents more than venture capital enthusiasm—it signals institutional confidence in quantum-AI convergence as a transformative force. With quantum computing revenues projected to exceed $1 billion in 2025 and the broader market expanding from $5.6 billion today to $97 billion by 2035, the commercial viability of quantum technologies is no longer a question of if, but when and how rapidly organizations will adapt.

Strategic Imperatives Demand Immediate Action

Three critical imperatives emerge from our analysis:

- **Security Transition**: The 86% unpreparedness rate among financial institutions for quantum threats, combined with the UK's 2035 post-quantum cryptography deadline, creates an urgent implementation timeline. The "harvest now, decrypt later" threat is not theoretical—it is happening today.
- **Competitive Positioning**: Organisations implementing quantum-AI solutions are demonstrating measurable advantages: 30% profitability increases in financial services, 40% energy efficiency improvements in battery management, and 20% logistics optimisation gains. Early adopters are establishing sustainable competitive moats.
- **Workforce Development**: The pronounced skills gap between quantum expertise demand and traditionally trained talent supply represents both a constraint and an opportunity. Organisations investing in quantum literacy today position themselves for long-term success.

Beyond Hype: Proven Commercial Applications

The sector has moved decisively beyond experimental phases. Financial institutions are deploying quantum-enhanced fraud detection systems, energy companies are optimizing renewable grids through quantum algorithms, and logistics providers are achieving double-digit efficiency improvements through quantum-powered optimisation.

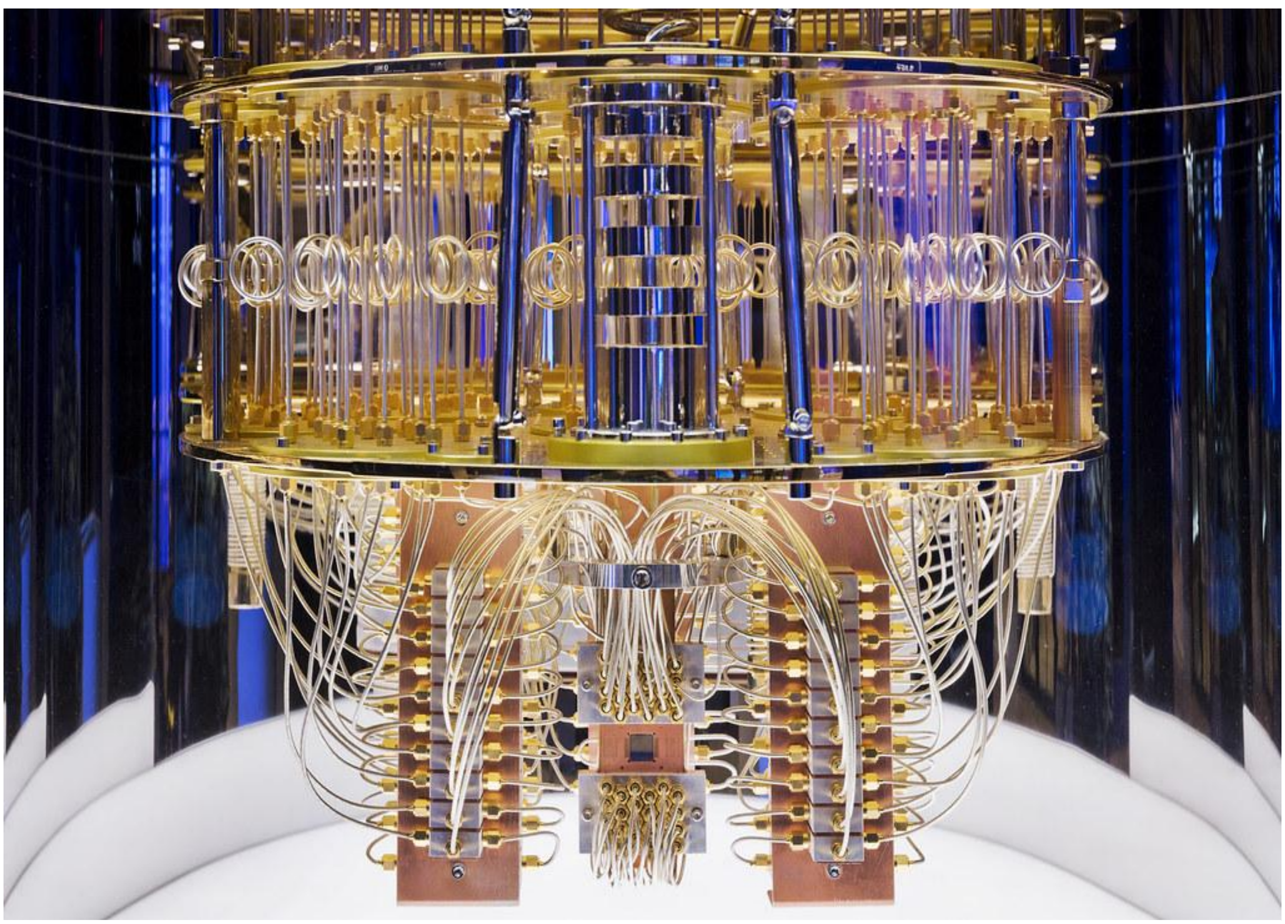
These applications demonstrate quantum technology's capacity to address real-world challenges whilst delivering measurable return on investment—a crucial milestone in technology adoption cycles.

The Path Forward

As we progress through the UN-designated International Year of Quantum Science and Technology, the strategic imperative for quantum readiness has crystallized. The convergence of quantum computing and artificial intelligence is not approaching—it is actively reshaping how organizations operate, compete, and create value across industries.

The quantum-AI revolution demands proactive engagement from business leaders, investors, and policymakers. Organisations that begin their quantum journey today will be positioned to capitalise on the exponential opportunities this technology convergence creates. Those that delay risk finding themselves at a permanent disadvantage in an increasingly quantum-enabled economy.

The future is quantum-AI enhanced, and that future is now.



7. Glossary

A

Algorithmic Trading - The use of automated computer programs to execute trading decisions based on pre-defined rules and quantitative analysis. In quantum finance, this can be enhanced by quantum algorithms for faster pattern recognition and optimization.

Artificial Intelligence (AI) - Technology consisting of machine learning algorithms and data models designed to perform tasks that typically require human intelligence, including data extraction, processing, and analysis in financial services.

Asset-Backed Currencies - Digital currencies tied to tangible reserves like gold, silver, or other commodities, ensuring stability and trust in quantum financial systems.

B

Bell State - A specific quantum state where two qubits are maximally entangled, fundamental to quantum cryptography and quantum key distribution protocols.

Big Data - The massive volume of structured and unstructured data that financial institutions collect, analyze, and leverage for AI-driven insights and quantum-enhanced processing.

Blockchain - A distributed ledger technology that maintains a continuously growing list of records, secured by cryptographic principles, often enhanced with quantum-resistant algorithms.

BQP (Bounded-Error Quantum Polynomial Time) - The class of decision problems solvable by a quantum computer in polynomial time, with an error probability of at most 1/3 for all instances.

C

Coherence - The ability of a quantum system to maintain stable and predictable phase relationships, preserving quantum properties like superposition and entanglement.

Cryptographically Relevant Quantum Computing (CRQC) - Quantum computers powerful enough to break current public-key cryptography systems, necessitating post-quantum cryptography adoption.

D

Decoherence - The loss of quantum coherence due to environmental interference, causing quantum systems to lose their quantum properties and behave classically.

Deep Learning - A subfield of machine learning that uses neural networks with multiple layers to process and analyze complex financial data patterns.

Derivatives Pricing - The mathematical modeling and valuation of financial derivatives, enhanced by quantum algorithms for more accurate and faster calculations.

Distributed Ledger Technology (DLT) - A digital system for recording transactions across multiple computers simultaneously, enhanced with quantum algorithms for improved security and efficiency.

E

Entanglement - A quantum phenomenon where two or more particles become correlated such that the quantum state of each particle cannot be described independently, regardless of distance.

ESG (Environmental, Social, and Governance) - Criteria used to evaluate investments and business practices based on environmental impact, social responsibility, and corporate governance standards.

Error Correction - Techniques used in quantum computing to detect and correct errors that occur due to decoherence and other quantum noise sources.

F

Fidelity - The degree to which a quantum state is preserved during quantum operations or measurements, typically expressed as a percentage.

Fraud Detection - The identification of unauthorized or suspicious financial activities, enhanced by quantum machine learning algorithms for pattern recognition.

G

Grover's Algorithm - A quantum algorithm that provides a quadratic speedup for searching unsorted databases, with implications for symmetric cryptography security.

H

Hadamard Gate - A fundamental quantum gate that creates superposition by placing a qubit in an equal combination of $|0\rangle$ and $|1\rangle$ states.

Harvest Now, Decrypt Later - A cybersecurity threat where adversaries collect encrypted data today with the intention of decrypting it once quantum computers become sufficiently powerful.

I

Impact Finance - Financing that produces verifiable positive impact on society and/or environment alongside financial returns, with quantum-enhanced measurement and verification.

J

Jitter - Variability in timing or amplitude of signals that can affect quantum random number generators and quantum communication systems.

K

Key Generation - The process of creating cryptographic keys for encryption and decryption, enhanced by quantum random number generators for true randomness.

L

Lattice-Based Cryptography - A post-quantum cryptographic approach based on mathematical problems involving lattices, believed to be resistant to quantum attacks.

M

Machine Learning (ML) - A subset of AI that enables systems to learn and improve from data without explicit programming, enhanced by quantum algorithms for financial applications.

Monte Carlo Simulation - A computational technique using random sampling to model complex financial scenarios, accelerated by quantum amplitude estimation.

N

Natural Language Processing (NLP) - AI technology that enables computers to understand and process human language, used in financial services for customer interaction and document analysis.

NIST (National Institute of Standards and Technology) - The U.S. agency that has standardized post-quantum cryptography algorithms for quantum-resistant security.

No-Cloning Theorem - A fundamental principle in quantum mechanics stating that arbitrary quantum states cannot be perfectly copied.

P

Portfolio Optimisation - The process of selecting optimal asset allocations to maximize returns while minimizing risk, enhanced by quantum computing for handling complex multi-variable scenarios.

Post-Quantum Cryptography (PQC) - Cryptographic algorithms designed to be secure against attacks by both classical and quantum computers, based on mathematical problems hard for quantum computers to solve.

Pseudo Random Number Generator (PRNG) - Deterministic algorithms that generate seemingly random numbers but are susceptible to quantum attacks.

Q

QAOA - Quantum Approximate Optimisation Algorithm

Quantum Algorithm - A sequence of quantum operations designed to solve specific problems, leveraging quantum properties like superposition and entanglement.

Quantum Cryptography - Cryptographic techniques that use quantum mechanical properties to secure communications, providing theoretically unbreakable encryption.

Quantum Key Distribution (QKD) - A secure communication method that uses quantum mechanics principles to detect eavesdropping attempts in key distribution.

Quantum Random Number Generator (QRNG) - Devices that generate truly random numbers using quantum mechanical processes, essential for cryptographic applications.

Qubit - The fundamental unit of quantum information, analogous to a classical bit but capable of existing in superposition states.

QUBO -Quadratic Unconstrained Binary Optimisation

R

RSA Algorithm - A widely-used public-key cryptographic system vulnerable to quantum attacks via Shor's algorithm, requiring post-quantum alternatives.

S

Shor's Algorithm - A quantum algorithm that can efficiently factor large integers, threatening current RSA and elliptic curve cryptographic systems.

Smart Contracts - Self-executing contracts with terms directly written into code, enhanced by quantum-resistant cryptography for future security.

Superposition - A quantum mechanical principle where particles can exist in multiple states simultaneously until measured, fundamental to quantum computing advantages.

T

True Random Number Generator (TRNG) - Hardware devices that generate random numbers from physical processes, enhanced by quantum phenomena for cryptographic applications.

U

Uncertainty Principle - A fundamental quantum mechanics principle stating that certain pairs of properties cannot be simultaneously measured with perfect precision.

W

Wigner Function - A mathematical tool used in quantum mechanics to describe quantum states in phase space, relevant to quantum finance modeling.

X

X-Basis Measurement - A type of quantum measurement performed on qubits in quantum computing and quantum cryptography protocols.

Y

Y2Q (Years to Quantum) - The timeframe until quantum computers become capable of breaking current cryptographic systems, driving urgency for post-quantum cryptography adoption.

Z

Zeno Effect - A quantum phenomenon where continuous observation prevents quantum system evolution, relevant to quantum error correction strategies.

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8. End Notes

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KQUANTA RESEARCH

9. About us

Kquanta Research stands at the forefront of innovation, occupying a unique space at the intersection of finance, artificial intelligence, quantum technology, and sustainability. As an independent research firm, we are dedicated to bridging the gap between cutting-edge technologies and their practical applications in the financial services sector. Our purpose is to accelerate the adoption of transformative technologies in the financial industry, with a particular focus on the Indian market and fostering global collaborations. We aim to be the catalyst that brings together technology innovators, academic researchers, and industry leaders to shape the future of finance.

What Sets Us Apart

- **Bridge Builders**: We serve as the crucial link between academia, technology developers, and industry practitioners, facilitating knowledge transfer and collaboration.
- **Focus on India**: While maintaining a global outlook, we specialise in understanding and addressing the unique needs and potential of the Indian financial market.
- **Global Collaboration**: We actively work to enhance international partnerships, bringing the best global practices to India and showcasing India's innovations to the world.

Our Approach

- **Comprehensive Research**: We conduct in-depth, independent research on the latest developments in financial services, AI, quantum technology, and sustainability.
- **Knowledge Dissemination**: Through white papers, workshops, and conferences, we make complex technological concepts accessible to finance professionals.
- **Strategic Consulting**: We provide strategic insights to help institutions navigate the adoption of AI and quantum technologies while adhering to sustainability principles.

Our Solutions

- **Executive Education and Thought Leadership**: Specialised workshops, seminars, and conferences for C-suite executives and senior leaders on financial innovations, emerging technology trends and their strategic implications
- **Quantum Tech, AI Awareness and Learning**: Comprehensive programs for professionals, educators, and students to understand quantum technology's impact on business and environment
- **Collaborative Networks**: We cultivate a robust network of academics, tech innovators, and industry leaders to foster cross-sector collaborations.

At Kquanta Research, we are not just observers of change – we are active participants in shaping a future where finance, technology, and sustainability converge to create value for businesses and society alike.

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