Technology Industries of Finland

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Recommendations for the EU Quantum Act and the Implementation of the Quantum Europe Strategy

Europe faces a critical juncture in quantum technology, where strategic choices in the coming years will determine its global position. The continent has world-class research capabilities, strong industrial frontrunners and early infrastructure investments. Yet the global race is intensifying, and without a clear and bold strategy, Europe will fall behind.

Technology Industries of Finland supports the EU's ambition to make Europe a global leader in the development, industrialisation and adoption of quantum technologies. The implementation of the Quantum Europe Strategy, unveiled in July 2025, and the forthcoming Quantum Act, expected in 2026, must deliver on three goals:

1. Ensure leadership in quantum computing, software, hybrid HPC-QC integration and quantum-safe cryptography
2. Accelerate industrialisation and adoption to turn research into economic and strategic value
3. Safeguard Europe's sovereignty and competitiveness through open but resilient ecosystems

These recommendations draw on *Finland's Quantum Technology Strategy 2025–2035* and the *Critical Digital Tech from Finland* policy brief. Finland has a lot to offer for the EU's success in the quantum era. The Finnish ecosystem shows how quantum computing, enabling hardware technologies, software, cryptography and hybrid infrastructures can be combined with industry-driven research and public–private alignment.

1 Governance & the Quantum Act

Europe stands at a pivotal moment in shaping its approach to quantum technologies. Without faster and more agile governance, such as through the planned Quantum Act, Europe risks falling behind global innovation. Swift, strategic action is essential to secure its leadership in quantum science and industry.

The Quantum Act offers Europe a chance to create an ambitious and coherent framework for quantum development. It should provide clarity on roles, priorities and conditions for investment while remaining agile enough to adapt to rapid technological change. The scope must include all domains of quantum technology but computing (QC) and its convergence with high-performance computing (HPC) should be the flagship, as hybridisation ensures early practical value, broad user access and anchors quantum in Europe's strongest digital assets.

Allocation of resources must be based on excellence and industrial demand, ensuring that funding flows to actors capable of delivering impact, and not on geographic balance or cohesion considerations. A Chips-Act-style structure that combines RDI, industrial capacity and economic security provides inspiration, but flexibility is essential to accommodate fast-moving innovation. Above all, regulation of emerging quantum technologies should remain light. Premature rules risk limiting experimentation and slowing growth at a moment when agility and freedom to innovate are critical.

For now, EuroHPC JU should remain the central anchor of European governance in this area, with an expanded mandate to integrate quantum infrastructures and hybrid HPC–QC systems. Other Joint Undertakings—such as Chips JU—should complement this role by focusing on

industrialisation, semiconductor development and technology supply chains that underpin both classical and quantum computing capabilities. As quantum technologies mature, a stand-alone, quantum-focused Joint Undertaking may eventually be warranted to address the specific governance, infrastructure and ecosystem needs of this emerging domain.

Key actions:

- Cover all domains but focus on quantum computing and HPC convergence
- Allocate resources by excellence and industrial demand
- Limit regulation to funding conditions only, keeping rules light and innovation-friendly and avoiding measures that could constrain experimentation or slow down industrial growth
- Make EuroHPC JU the central governance body, complemented by Chips JU and others, with a view to establishing a dedicated quantum JU as the field matures

2 Research & Innovation

Europe's success in quantum will depend on its ability to translate scientific strength into industrial leadership. The EU must shift from fragmented projects toward a model where companies lead ambitious, outcome-driven R&D, supported by world-class research institutions. Public funding should accelerate results by backing mission portfolios and fast instruments rather than dispersing resources across too many small initiatives. A clear benchmarking and grand challenge framework with substantial funding would help measure progress and concentrate investments where Europe can achieve global impact.

Excellence must remain the guiding principle. Resources should flow to those actors that can demonstrate both technical capability and industrial relevance. This requires a research and innovation model that prioritises collaboration between leading companies, universities and applied research organisations. The proposed EU Tech Frontrunners initiative under the European Competitiveness Fund may also prove useful for quantum, as it embodies a company-led model that ensures rapid feedback loops between research, technology development and market adoption.

Near-term industrial and dual-use applications should be explicitly prioritised in R&D funding to demonstrate value and build momentum. Defence-related use cases are strategically important for Europe's sovereignty and must be addressed in a way that allows civil and military programmes to reinforce each other.

Key actions:

- Shift to company-led, excellence-based R&D funding focused on firms capable of translating research into industrial impact
- Launch a European grand challenge with sufficient funding
- Explore adapting the best practices of the Tech Frontrunners model to quantum
- Establish dedicated funding programmes for dual-use quantum R&D, separate from the European Defence Fund and European Defence Agency's funding of large-scale quantum computers for classified defence use cases

3 EuroHPC Infrastructure & Strategic Procurement

Europe has taken important first steps by integrating quantum systems into EuroHPC supercomputing centres, but the next phase requires a more structured and user-driven approach. Procurement must not be seen as a one-off purchase but as the engine of a continuous feedback loop that accelerates innovation, strengthens industry and builds user communities.

Hybrid HPC-QC integration should be a defining feature of this approach. By embedding quantum processors as accelerators within Europe's HPC infrastructure, procurements can deliver early benefits, attract new user communities and ensure that quantum investments are anchored in Europe's digital strengths. AI Factories and AI Gigafactories provide a natural extension of this model, serving as platforms where hybrid HPC-QC systems can be deployed to power advanced AI development and link Europe's digital strategies together. They also support the *AI in Science Strategy's* aim to align computational capacity with Europe's scientific priorities and future technological trends.

A virtuous cycle of procurement can make this model sustainable. When EuroHPC or other entities procure QC systems, they generate revenue for European vendors and stimulate IP creation in Europe. Procurement budgets should not only cover infrastructure and maintenance but also fund education and research from the outset, ensuring full utilisation and strengthened talent pipelines. Research organisations and universities can then license results to companies, feeding next-generation products into the cycle. As EuroHPC purchases subsequent generations of devices and AI Factories expand their integration, private demand grows, reinforcing the loop.

Key actions:

- Make the virtuous cycle of procurement a guiding principle for EuroHPC and other EU quantum procurements and embed user feedback into procurement decisions
- Ensure hybrid HPC-QC integration is central to all strategies and deploy hybrid systems also through AI Factories and AI Gigafactories to connect quantum with Europe's AI ecosystem
- Guarantee that procurement budgets cover hardware, maintenance, education and research from day one
- Prioritise EU-headquartered vendors while remaining open to trusted partners, particularly for key components and materials that Europe currently lacks

4 Industrialisation & Testbeds

Europe's ability to lead in quantum will depend on how quickly it can move from prototypes to industrial-scale production. While research excellence is a strength, the bottleneck lies in scaling technologies into reliable, manufacturable systems. The upcoming *Quantum Chips Industrialisation Roadmap* in 2026 will be a critical instrument for this transition, and it must focus on enabling the rapid industrialisation of quantum processors and components in Europe.

Pilot lines are central to this effort. The EU is already moving to establish them, but they must be further fostered and built upon to maximise their impact. They should support startups and SMEs by providing access to advanced tooling and cleanroom facilities that individual firms cannot afford on their own. These shared facilities will enable companies to validate processes, develop chips and begin scaling production. As pilot lines demonstrate their value and technologies mature, Europe should take the next step and establish a dedicated quantum foundry. This first-of-a-kind facility would consolidate the most critical tools and processes into a permanent industrial infrastructure, bridging the gap between R&D prototyping and commercial-scale manufacturing. Supported through the Chips Act or a similar framework with EU, national and private co-investment, such a foundry would anchor quantum processor production in Europe and ensure that key know-how and supply chains remain under European control.

A Europe-wide, open-access network of testbeds or Quantum Sandboxes should complement these pilot lines. They must be understood broadly: not only physical facilities but also cloud-based access points that enable widespread experimentation with European-owned quantum systems. By embedding these Sandboxes into AI Factories and EuroHPC centres, Europe can

ensure that quantum technologies are connected to its strongest digital infrastructures, attract diverse user communities and accelerate the development of algorithms and applications.

Key actions:

- Strengthen and expand pilot lines so that they effectively support startups and SMEs through shared cleanroom and tooling access
- Support the creation of a European quantum foundry as a first-of-a-kind facility under the Chips Act or a similar framework
- Build a Europe-wide network of open-access testbeds or Quantum Sandboxes that includes both physical facilities and cloud-based access
- Align closely with Chips JU to coordinate semiconductor and quantum strategies

5 Capital & Intellectual Property

Europe's quantum sector is constrained by gaps in scale-up capital and predictable frameworks for commercialisation. Early-stage funding is relatively well covered, yet late-stage growth rounds remain scarce. This leaves Europe's most promising quantum companies vulnerable to acquisition or relocation, with their intellectual property and talent at risk of leaving the continent. To secure Europe's leadership, capital gaps must be closed and IP frameworks must be designed to enable, not hinder, industrial growth.

The EU should create dedicated mechanisms for patient capital at scale. A European Critical Tech Fund, building on existing instruments such as InvestEU and the EIC, could provide long-term growth financing for quantum companies. Blended finance instruments and an expanded role for the EIB should be used to reduce risk for private investors and keep scale-ups anchored in Europe.

Clear and business-friendly rules on IP are equally important. Today, EU-funded projects often leave ownership of results with research organisations, which limits companies' ability to use and commercialise innovations they helped develop. Collaborative projects, pilot lines and Quantum Sandboxes should operate under IP frameworks that balance contributions fairly and allow vendors to exploit and license results. Without such clarity, investment will remain constrained and companies will be discouraged from committing their best technologies to European programmes.

Key actions:

- Establish a European Critical Tech Fund for long-term capital
- Expand EIC and EIB instruments to co-finance later-stage growth rounds and de-risk private investment
- Adopt business-friendly IP frameworks for EU-funded collaborative infrastructure and projects

6 Demand Creation & Early Markets

Europe cannot rely on supply-side measures alone. For quantum technologies to scale, there must be sufficient demand to drive adoption and validate business models. At present, industrial uptake remains limited, and public buyers are often hesitant to act as first movers. Without early markets, even the most advanced European technologies risk stagnating.

Beyond the EuroHPC-driven procurements of infrastructure, public procurement should also be used strategically to create demand in broader sectors of the economy. Innovation-oriented models—such as pre-commercial procurement and innovation partnerships—allow public buyers

to co-develop emerging solutions while mitigating risk. Coordinated European approaches, supported by a shared procurement toolbox—for example, common framework contracts and standardised IP templates—can consolidate fragmented demand across Member States and create lead markets. Early customers in fields such as health, energy, transport and secure communications can demonstrate the value of quantum solutions and send strong market signals.

Demand creation must also encompass quantum software and algorithm development. Without algorithms addressing real-world challenges, even the most advanced hardware cannot deliver tangible value. Europe should therefore support the development of a European quantum software stack comprising platforms, algorithm design and hybrid solutions that can run on today's small and medium-scale quantum devices. By investing in this stack, Europe can enable early applications, foster user communities and strengthen its position in global software standards.

Equally important is ensuring that quantum applications are developed in close collaboration with users. By linking quantum developers with industrial clusters, research organisations and public bodies, the EU can accelerate co-investment and generate use cases that prove the technology's value. Industrial users in manufacturing and other sectors should be integrated into these clusters, where they can co-develop applications together with quantum technology providers. AI Factories and EuroHPC centres can also play a pivotal role by connecting quantum providers with Europe's most data- and compute-intensive communities.

Key actions:

- Foster innovation-oriented procurement mechanisms, such as pre-commercial procurement and innovation partnerships, tailored to quantum projects outside of EuroHPC
- Establish a shared European procurement toolbox to consolidate demand and enable cross-border projects supporting a sovereign European hardware and software supply chain
- Encourage public bodies to act as early adopters in health, energy, transport and secure communications
- Support quantum software platforms and algorithm development as essential enablers of demand and early adoption
- Strengthen innovation clusters linking quantum developers with industrial users, and use EuroHPC centres, AI Factories and AI Gigafactories as adoption platforms

7 Quantum-Safe Europe

The transition to quantum-safe cryptography is urgent not only for security, but also because it is creating a global market that is maturing now, well ahead of the commercial quantum computing market. Once quantum computers reach maturity, they will be able to break widely used encryption, threatening Europe's digital infrastructure, businesses and public services. Adversaries may already exploit this risk through "harvest now, decrypt later" strategies. Europe must act early and decisively to secure its digital systems.

The most reliable path forward is post-quantum cryptography (PQC), based on internationally recognised standards. Europe should avoid fragmentation and focus resources on scalable, standards-based solutions. Quantum Key Distribution (QKD) may play a role in selected secure communication cases, but PQC offers the only broad and practical path for protecting European systems in the near to medium term.

Key actions:

- Reaffirm PQC as the cornerstone of Europe's quantum-safe transition and redirect EU funding to prioritize PQC, limiting QKD to specialised niche applications
- Provide a European procurement toolbox for PQC adoption across public and private sectors
- Coordinate Member State efforts for a harmonised and standards-based quantum-safe migration

8 Skills & Talent

Europe's ability to lead in quantum will depend on skilled people across both technology providers and users. Expertise is already scarce, and global competition is intensifying. Without decisive action, Europe risks losing specialists to regions offering more attractive opportunities and career pathways. Sustained leadership requires coordinated education initiatives and policies that attract, develop and retain a highly qualified workforce in Europe.

The European Quantum Skills Academy is presently underfunded and should be strengthened as the central hub for education and training. It should go beyond its current academic curricula to include applied industry tracks open to engineers, machinists, micromechanics and other technical professions, with access to labs, equipment and European software stacks. The Academy should also develop quantum-specific and quantum-capable talent across professions by combining scientific and technical training with skills in commercialisation, legal literacy and customer engagement. In coordination with the EU, reskilling and upskilling programmes should support existing professionals along the quantum value chain—from design and manufacturing to end use—ensuring that Europe builds a sustainable, competitive and security-conscious quantum workforce.

Finnish initiatives such as InstituteQ and the national doctoral education pilot show how industry, academia and government can join forces to produce high-quality talent pipelines. These models should be scaled at the European level.

Mobility is equally important. Europe needs a dedicated Tech Talent Visa and fast-track schemes to attract highly specialised experts who are not readily available in Europe. Universities should partner with startups and established firms to provide clear pathways from academia to industry for students and researchers.

Key actions:

- Strengthen the Quantum Skills Academy with applied tracks and lab access
- Ensure EU funding prioritises equipment access and real-world projects for students and early-career researchers
- Introduce an EU Tech Talent Visa and fast-track schemes
- Support partnerships between universities, startups and industry to create clear career pathways into quantum companies

9 Security & Defence

Quantum technologies will have profound implications for Europe's security. From sensing and navigation to secure communications and computing, their dual-use nature requires that civil and defence initiatives are aligned rather than siloed. If Europe fails to coordinate, it risks duplication, fragmentation and strategic dependency.

The EU should prioritise a framework where civil innovation feeds into defence applications through structured "spin-in" mechanisms. Startups and scaleups that develop quantum

technologies should have clear pathways to collaborate with defence actors, ensuring that capabilities developed for industrial or research use can also strengthen European security. Defence-related use cases such as sensing, positioning, navigation and timing are particularly critical and should be explicitly supported.

Export controls and investment screening must be applied with care. Safeguards are essential to prevent the leakage of sensitive technologies to hostile actors, but overly restrictive regimes risk creating uncertainty and deterring private investment. Europe needs a balanced, coordinated approach across Member States that protects security without undermining competitiveness. Restrictions on European technologies should be matched by reciprocal measures on market access to uphold a global level playing field, particularly as some actors benefit from closed domestic markets. Close coordination with allies is vital to maintain technological leadership and protect Europe's strategic interests in the quantum domain.

Key actions:

- Create structured spin-in mechanisms linking startups and scaleups with defence programmes
- Ensure export controls and investment screening remain light-touch, coordinated and supportive of a level playing field
- Coordinate civil and defence programmes to avoid duplication
- Build trusted partnerships for defence-related quantum R&D with like-minded allies

10 International Cooperation & Standards

Quantum technologies are advancing globally, and Europe cannot develop in isolation. Strategic cooperation with like-minded partners is essential to accelerate innovation, strengthen supply of key components and safeguard economic security. At the same time, Europe must ensure that cooperation is reciprocal and does not create dependencies on external suppliers or platforms.

International partnerships should focus on countries that share Europe's values and strategic interests. Reciprocal access to infrastructures and inputs, joint calls for R&D and coordinated funding instruments can accelerate progress and transform dependencies into strategic value chains, while maintaining European control over critical technologies. Clear economic security criteria should guide these collaborations, ensuring that Europe's intellectual property and industrial base are protected.

Standards are another decisive arena. Europe must be active in shaping global quantum standards to ensure interoperability, security and fair competition. This means investing in European participation in international standardisation bodies, while also promoting open and transparent processes that reflect Europe's interests. Aligning standards for quantum computing, software platforms and cryptography will be crucial for building trusted markets and reducing fragmentation.

Key actions:

- Build reciprocal partnerships with like-minded countries, based on reciprocity and shared economic security criteria
- Facilitate European participation in international standardisation processes for quantum computing, software and cryptography
- Pursue open global standards to strengthen interoperability
- Anchor international cooperation in a framework that safeguards Europe's IP and industrial competitiveness

11 Metrics & Milestones

For the EU Quantum Strategy and the planned Quantum Act to deliver, progress must be tracked against clear and measurable objectives. Suggested 2026–2030 targets include:

- **Research & Innovation**: European benchmarking and grand challenge launched by 2026
- **Infrastructure**: Hybrid HPC-QC systems deployed across EuroHPC and AI Factories by 2027
- **Industrialisation**: Strengthened pilot lines and a first-of-a-kind foundry operational by 2028
- **Testbeds**: Network of open-access Quantum Sandboxes live by 2027
- **Capital**: Critical Tech Fund operational by 2026, with major late-stage financing rounds by 2030
- **Demand Creation & Early Markets**: European procurement toolbox rolled out by 2026; support for software and algorithm development; adoption roadmaps in health, energy, transport and secure communications
- **Quantum-Safe**: PQC migration underway in critical sectors by 2027; harmonised EU-wide adoption by 2030
- **Skills**: Quantum Skills Academy fully operational with applied tracks by 2026; EU Tech Talent Visa in place by 2027
- **Security & Defence**: Spin-in mechanisms established and at least two flagship dual-use projects in sensing or PNT launched by 2028
- **International Cooperation & Standards**: Reciprocal access agreements with at least three like-minded partners and strengthened European participation in global standardisation bodies by 2027

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