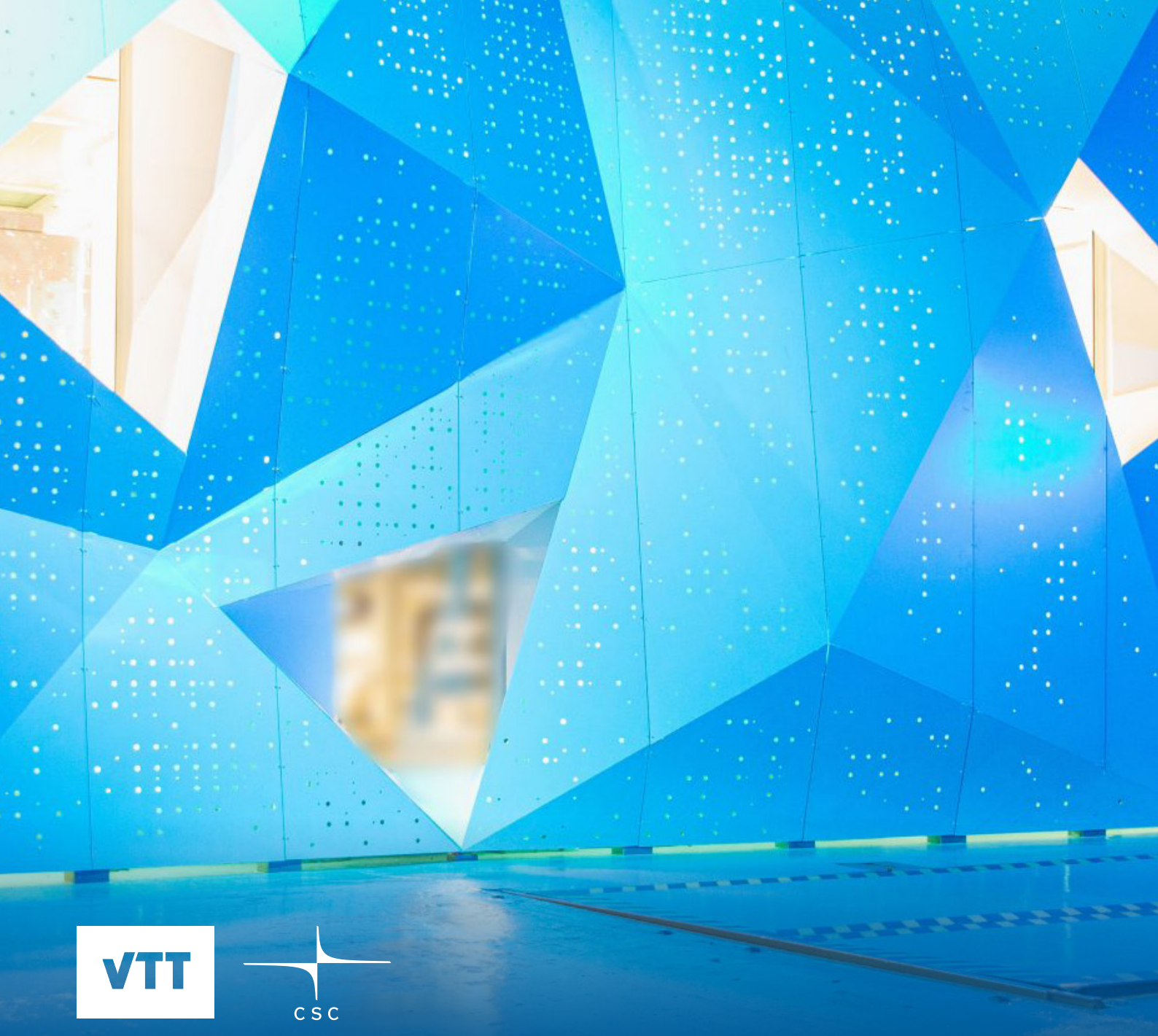

The future of innovation:

Hybrid high performance computing + artificial intelligence + quantum computing

Hybrid HPC+AI+quantum computing is moving from future potential to practical exploration today. It opens new research directions and strengthens international impact. It offers a structured way to de-risk emerging technology, build capability, and identify where hybrid methods can create competitive advantage.

Finland offers a low-threshold way to start: world-class compute and AI environments paired with quantum computing services and application expertise, all supported through a service model designed for both academia and industry.

Photo: Mikael Kanerva / CSC

Why early research is important for R&D leadership

The next era of R&D will be shaped by organisations that can combine **simulation, data, and optimisation** at scale. High-performance computing (HPC) and artificial intelligence (AI) are already essential, and quantum computing (QC) is emerging as a complementary capability. The winners will be those who develop hybrid competence early: methods, tools, teams, and realistic use cases.

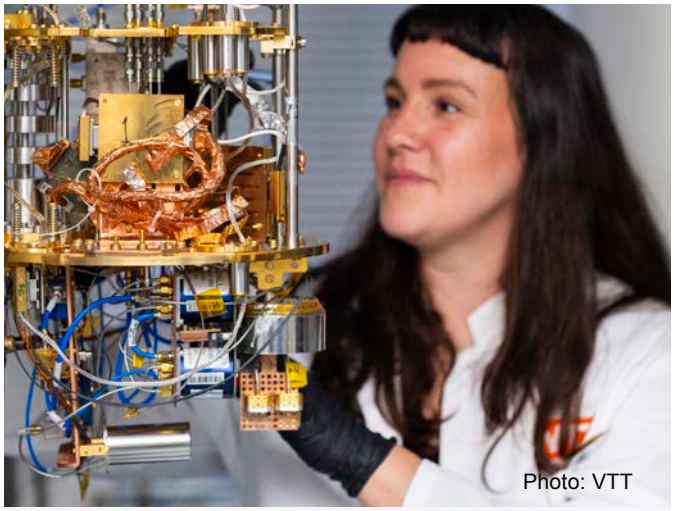

Photo: VTT

Early engagement is a practical way to build readiness by:

- building expertise and talent in quantum-era computing and hybrid methods
- identifying which problems are quantum-relevant
- developing IP, scientific publications, and partnerships ahead of the curve
- preparing for rapid uptake as hardware and software capabilities grow

The time to start is when you can still learn fast and shape how the ecosystem develops, **and that is now**.

Benefits of hybrid HPC+QC+AI computing

Hybrid computing combines the strengths of supercomputers, AI, and quantum computers into a versatile platform for demanding challenges. HPC excels at large-scale parallel simulation, modelling, and numerical computation. AI accelerates discovery by learning patterns, automating analysis, and supporting decision-making. Quantum computing can offer advantages for many workloads, such as complex optimisation, molecular and materials modelling, and emerging quantum machine learning approaches.

When combined, the whole can be greater than the sum of its parts. For example, AI can guide hybrid workflows, while HPC handles large-scale pre- and post-processing around quantum routines. This enables practical experimentation today and creates a path toward future performance advantages.

Hybrid approaches are particularly relevant for:

- Materials and chemical processes (modelling, discovery pipelines)
- Drug development and life sciences (simulation + data-driven screening)
- Logistics, energy systems, and manufacturing (complex optimisation and scheduling)
- Machine learning (hybrid methods, new model types, accelerated workflows)

“The launch of the VTT Q50 quantum computer in March 2025 was an important milestone for Europe’s quantum ecosystem. By using the VTT Q50 together with the LUMI supercomputer, we have achieved some of our best results to date, considering all competing technologies.”

Valtteri Lahtinen, Chief Scientist / Co-Founder, Quanscient

Photo: Quanscient simulation modeling

Success story:

Quanscient and hybrid classical-quantum computing as a driver of product development

Quanscient is a pioneer in next-generation simulation-driven product development using hybrid approaches. Its flagship simulation platform, Quanscient Allsolve, targets major reductions in simulation turnaround times, enabling faster iteration and decision-making in product development.

The hybrid approach enables Quanscient to develop both current and future computational solutions by leveraging the best aspects of classical and quantum computing.

The company’s own research group, Quanscient Quantum Labs’ goal is to integrate quantum algorithms into the Allsolve platform during this decade, positioning customers to benefit as hybrid methods and hardware evolve.

This approach not only shortens the product development cycle but also enables the discovery of entirely new solutions to challenges. Quanscient is building its position among the future’s success stories by fully embracing hybrid computing.

Photo: CSC

LUMI, LUMI AI Factory, and VTT Q50 –

an integrated environment for research and industry

Finland offers a uniquely practical setting for hybrid computing. World-class supercomputing, advanced data and AI environments, quantum computing services, and strong application expertise are brought together so that research groups and companies can develop and test real hybrid workflows rather than isolated technology pilots.

The present HPC/AI core is LUMI, the top-tier EuroHPC supercomputer located in CSC's data center in Kajaani, hosted by the 11-country LUMI consortium. It provides the large-scale resources needed for simulation, modelling, and data-intensive workloads, and thus forms the natural "classical backbone" around which hybrid workflows are built. Expanding on this foundation, the LUMI AI Factory strengthens capabilities for AI development and deployment, helping organisations move from experimentation to scalable, repeatable AI pipelines in a secure, high-performance environment.

Complementing these capabilities, VTT's quantum computer Q50, designed and manufactured in Finland, provides hands-on access to the most advanced European quantum computing hardware.

Together, these capabilities form an integrated environment where supercomputers, quantum computers and AI support one another and enable faster innovation: HPC for heavy lifting and integration, AI for automation and acceleration, and quantum computing for targeted routines where it can add value.

This is further supported by a service ecosystem designed for both academic and industrial users, including the expertise needed to develop algorithms, applications, and hybrid workflows.

The future of innovation: Hybrid high performance computing + quantum computing + artificial intelligence

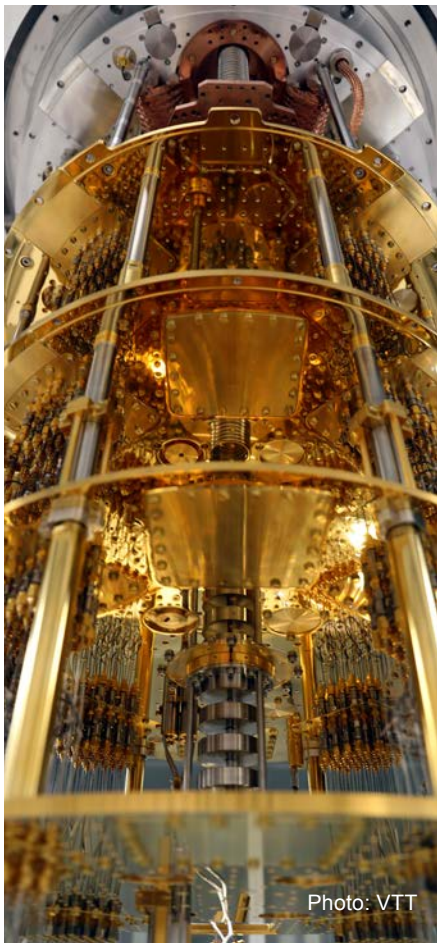

Photo: VTT

Finland’s hybrid infrastructure is available now

The key message is simple: **you can start now**! A practical service model is available for both academia and industry, including no-cost access routes through public research campaigns and calls (for academic and company use), and paid services designed for commercial R&D needs and tailored support.

Beyond access to computing, organisations also need support to succeed. We provide guidance for onboarding, tooling, and method development, helping research groups and companies move **from interest to measurable progress,** while addressing practical needs such as skills development, data handling, and project setup.

The infrastructure is also available for **education**, enabling hands-on HPC, AI, and quantum computing training as part of, for example, higher education courses.

Road ahead:

Scaling Finland's hybrid HPC + AI + quantum capability

Finland is continuously strengthening hybrid HPC+AI+Quantum as a practical, growing capability for research and industry. Over the next few years, stakeholders can move from early pilots to larger, more ambitious hybrid workflows.

Two developments are especially important:

- **National quantum capability scales toward 300 qubits.** Finland's quantum roadmap targets a 150-qubit system in 2026 and a 300-qubit system in 2027. This growth will broaden the set of hybrid use cases that can be meaningfully explored, especially in materials science, optimisation, simulation, and emerging quantum-enhanced AI methods.
- **The LUMI AI Factory expands towards quantum AI** with the AI-optimised LUMI-IQ quantum platform in 2027. This will make combined AI + quantum workflows more scalable and easier to adopt in practice, supporting everything from exploration to production-level runs in R&D settings.

Example use cases

- Development of new molecules and materials, such as catalysts and batteries
- Advanced optimisation of logistics, routing, energy networks, and risk management
- Quantum machine learning for pattern recognition, predictive modelling, and data-driven decision support

Computing platforms

- LUMI and ROIHU supercomputers
- LUMI AI Factory and LUMI-IQ
- Quantum computers Q50, Q150, Q300+

Finland's national and international collaboration with peers and industry leaders further enhances capabilities, strengthening Finland's position as a pioneer in innovation and infrastructure services.

Photo: Mikael Kanerva / CSC

The future of innovation: Hybrid high performance computing + quantum computing + artificial intelligence

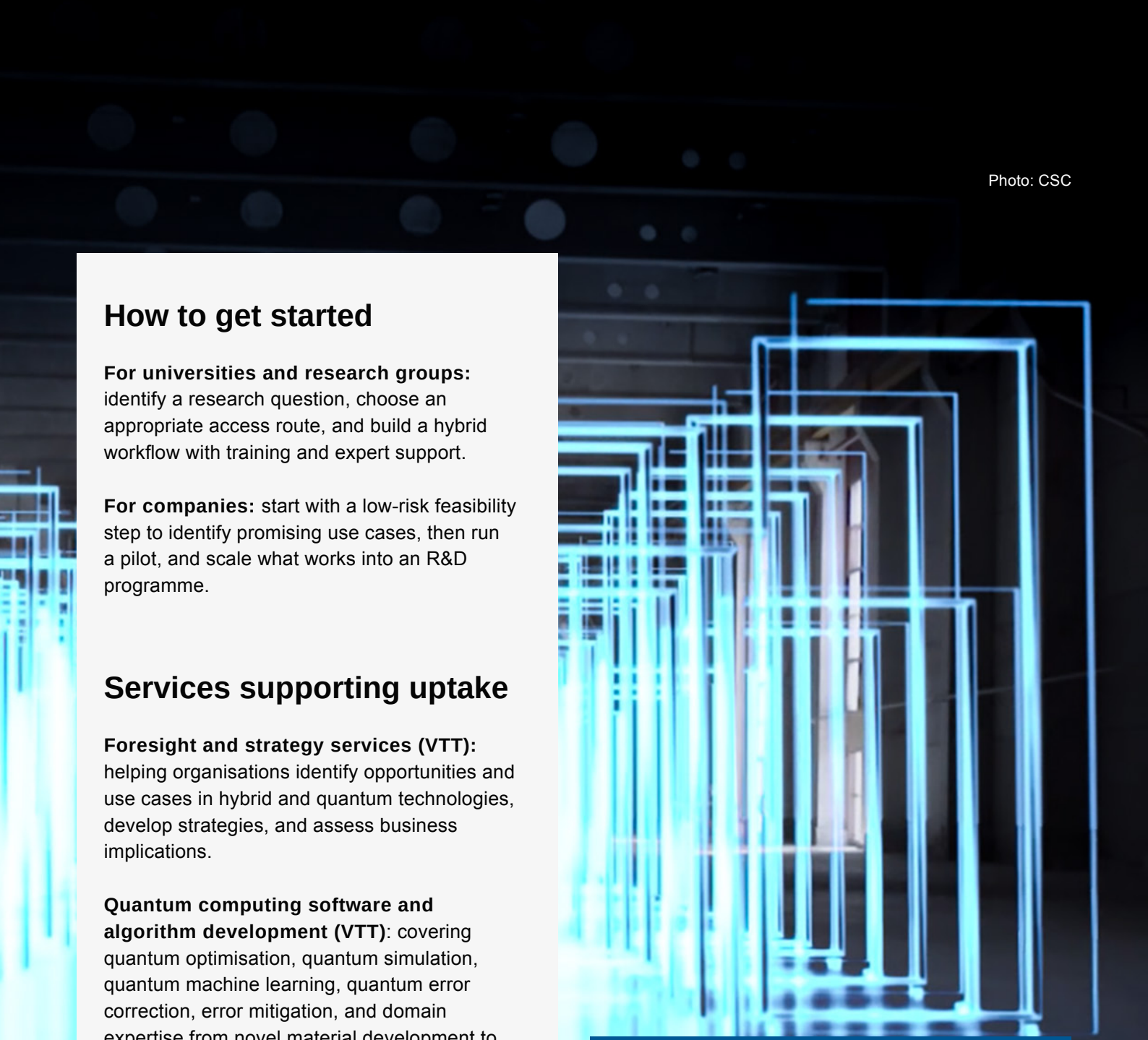

Photo: CSC

How to get started

For universities and research groups: identify a research question, choose an appropriate access route, and build a hybrid workflow with training and expert support.

For companies: start with a low-risk feasibility step to identify promising use cases, then run a pilot, and scale what works into an R&D programme.

Services supporting uptake

Foresight and strategy services (VTT): helping organisations identify opportunities and use cases in hybrid and quantum technologies, develop strategies, and assess business implications.

Quantum computing software and algorithm development (VTT): covering quantum optimisation, quantum simulation, quantum machine learning, quantum error correction, error mitigation, and domain expertise from novel material development to industrial process optimisation.

Hybrid HPC+AI+QC infrastructure, services, and application support (CSC): enabling efficient use of large-scale compute and AI platforms and supporting practical hybrid workflows from onboarding to performance and scalability. Infrastructure is also available for education and courses at higher-education institutions.

For more details:

Quantum computing services & innovation | VTT
https://www.vttresearch.com/en/ourservices/quantum-computing

Quantum computing enables new types of breakthroughs | CSC
https://csc.fi/en/our-expertise/quantum-computing/

VTT

VTT is a visionary research, development and innovation partner, and one of the leading technical research organisations in Europe. We have over 80 years of experience in cutting-edge research and science-based results. Our more than 2,000 professionals work to develop systemic and technological solutions that can bring about fundamental transformation.

Read more: https://vttresearch.com/

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