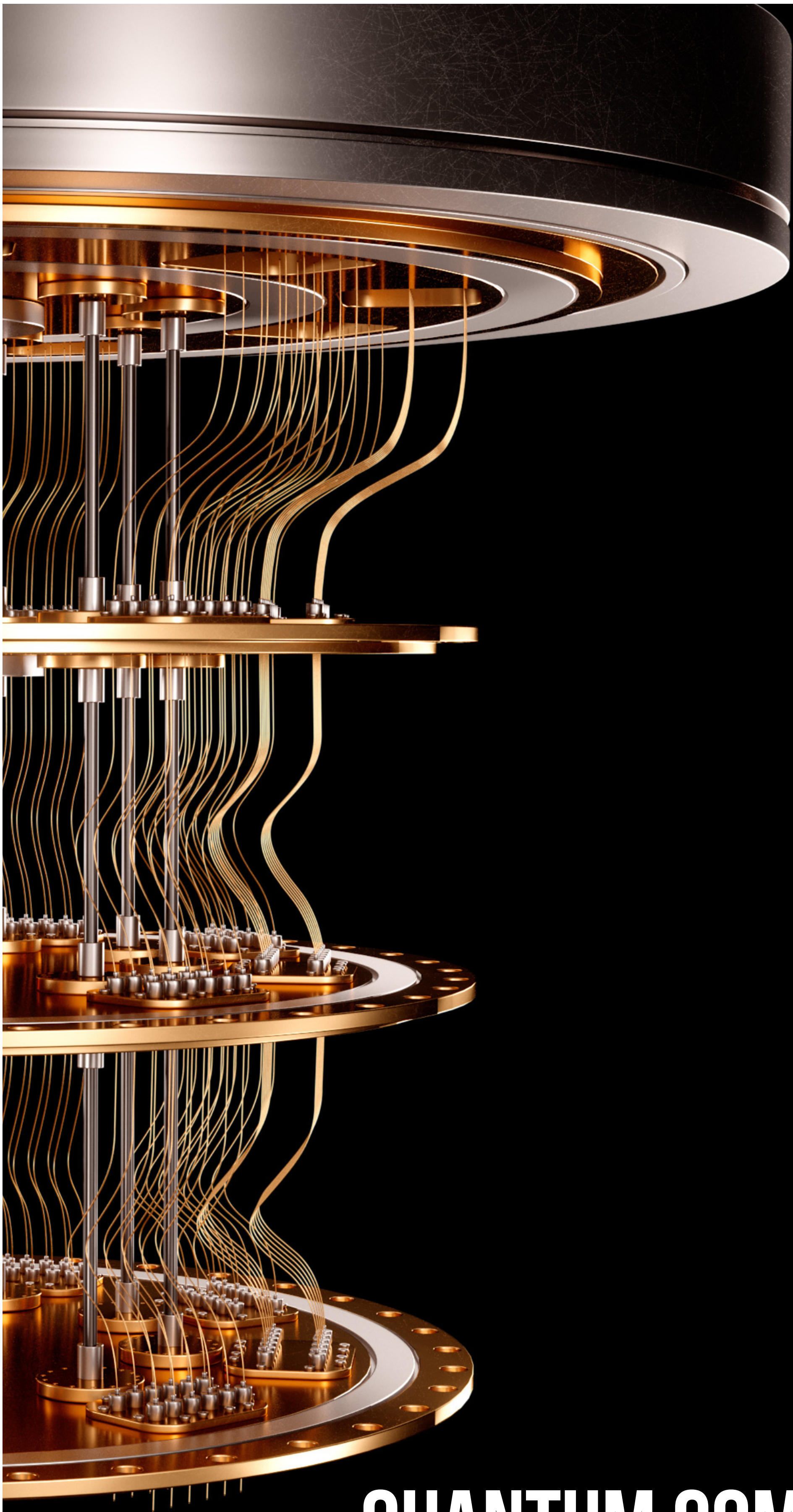


QUANTUM COMPUTING IN THE EuroHPC JU ECOSYSTEM

A Practical Guide for European SMEs

EXECUTIVE SUMMARY

Quantum computing is no longer just for tech giants. European SMEs can now harness the power of quantum computing through expert guidance and specialised training from the EuroHPC JU ecosystem, without major upfront investment.

Quantum computing (QC) has the potential to tackle certain problems that current classical computing would require substantial resources to solve, or could not solve at all. This white paper is designed for small and medium-sized enterprise (SME) leaders and European industry professionals who want to understand how QC could benefit their businesses. The EuroHPC Joint Undertaking (EuroHPC JU) is building a heterogeneous computing ecosystem that includes CPUs, GPUs, and more recently QPUs (Quantum Processing Units).

The EuroHPC JU is deploying ten quantum computers across Europe, offering six different qubit modalities: superconducting, neutral atoms, photonic, trapped ions, quantum annealing, and semiconductor spin qubits. These systems are hosted in eight countries and connected to powerful classical supercomputers, enabling hybrid workflows where quantum and classical resources work together. This diversity allows SMEs to experiment with different technologies and find the best fit for their specific challenges.

The technology is currently in the Noisy Intermediate-Scale Quantum (NISQ) era, where quantum processors have a limited number of qubits and are susceptible to errors. Although fault-tolerant quantum computers are still being developed, SMEs can benefit from starting now with current NISQ devices. Quantum computing shows promise across business areas such as: optimisation problems in logistics and scheduling, product development including materials science and drug discovery, machine learning for pattern recognition, and financial modelling for risk analysis. This paper maps quantum algorithms to specific applications across different industry sectors such as pharmaceuticals, chemicals, energy, telecommunications, manufacturing, logistics, and finance.

National Competence Centres (NCCs) and the European Quantum Excellence Centre (QEX) serve as key entry points for SMEs. Together, they facilitate access, provide support, and guide SMEs to best utilise the resources. Their services and offerings in quantum computing are discussed throughout the paper.

For SMEs, this evolving ecosystem offers a unique opportunity to explore quantum computing, experiment with different hardware and use cases, and begin developing quantum-ready skills without significant upfront costs. Early engagement builds internal expertise and positions organisations to capture value as the technology matures.

FROM FEYNMAN'S INSIGHTS TO CURRENT ADVANCES

From Feynman's vision to Shor's breakthrough algorithm, quantum computing has evolved from theory to reality, unlocking solutions to challenges currently beyond our computational reach.

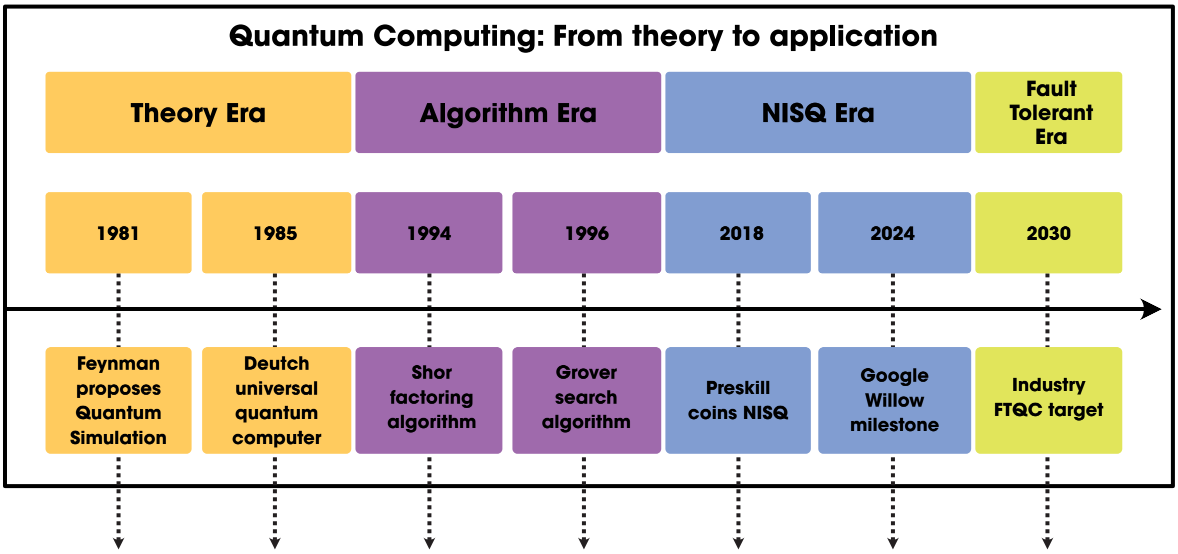
Quantum computing (QC) is a revolutionary approach to computation. It uses the principles of quantum mechanics, such as superposition, entanglement, and interference, to tackle problems that current classical computers cannot solve efficiently.

A classical bit holds a value of either 0 or 1, while a quantum bit (qubit) exists in a superposition state that encodes probabilities of both outcomes. When measured, this state collapses to either 0 or 1. Quantum entanglement links qubits so that measuring one determines properties of another. This enables processing relationships across qubits in ways impossible classically. Quantum algorithms that build on these principles could solve complex problems facing many domains.

Richard Feynman laid the theoretical foundations in 1981, proposing at MIT that simulating quantum physics would require quantum mechanical devices. A pivotal moment came in 1994 with Peter Shor's development of a quantum algorithm at Bell Labs. Shor demonstrated that quantum computers could factor large numbers in polynomial time, a task that takes much longer on classical computers. This breakthrough has significant implications for cryptographic security. In 2024, NIST finalised new post-quantum cryptography standards in response.

Two years later, Lov Grover developed an algorithm offering faster searching through unstructured databases. Whilst Shor's algorithm provides dramatic acceleration for specific mathematical problems, Grover's algorithm offers more modest but broadly applicable speedups.

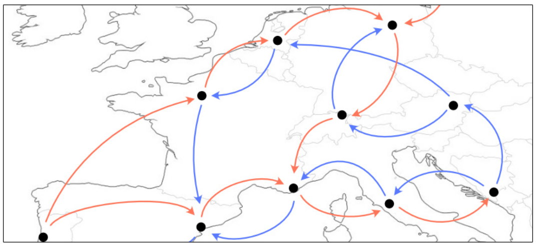
Today, we are in the Noisy Intermediate-Scale Quantum (NISQ) era, a term introduced by John Preskill in 2018 describing devices with 50 to 1,000 qubits that lack full error correction. Meanwhile, recent advances in the field are promising, such as Google's Willow chip introduced in late 2024, demonstrating that error correction improves as the system scales. Industry leaders are targeting fault-tolerant quantum computers by 2030. The below timeline visualises advances in the field.



HOW QUANTUM COMPUTING CAN TRANSFORM BUSINESS CHALLENGES

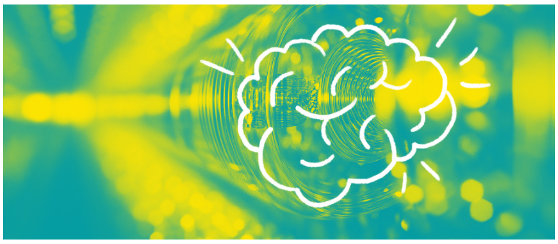
Quantum computing offers significant promise for SMEs facing complex computational challenges across several domains with examples here.

OPTIMISATION PROBLEMS



These are common in supply chain optimisation, logistics, planning the best delivery routes, electric grid distribution, managing vehicle fleets and autonomous systems, scheduling, resource allocation, production process optimisation, and fault detection in manufacturing lines. These tasks often need significant computing power or a different algorithm that could solve the problem from another angle. Quantum algorithms could solve these problems more effectively. Route optimisation using the Travelling Salesman Problem is one common use case.

DATA ANALYSIS AND MACHINE LEARNING



Quantum machine learning (QML) approaches may enhance pattern recognition capabilities and integrate with deep learning algorithms in hybrid workflows. This could enable SMEs working with large datasets or complex classification tasks to refine their solutions. The broader intersection of neural networks, artificial intelligence, large language models (LLMs), and quantum computing represents an active research area, aiming to harness quantum principles for the next generation of AI.

PRODUCT DEVELOPMENT

For SMEs working in manufacturing, materials science, pharmaceuticals, or chemicals, quantum computing could speed up their R&D. Using quantum algorithms could help drive their value delivery, for example by enabling better product manufacturing line optimisation and accurate molecular modelling. This can accelerate the design of new products, drug discovery or new materials such as photovoltaics in solar panels, battery materials, catalysts for carbon capture applications, or self-healing materials.

FINANCIAL MODELLING

SMEs and institutions in the financial sector could benefit from quantum algorithms for portfolio optimisation, option pricing, and credit Value at Risk calculations. These applications leverage quantum Monte Carlo methods and quantum amplitude estimation to handle complex financial modelling scenarios.

These applications show how quantum computing might address computational challenges, resulting in significant gains in competitiveness and innovation capacity.

EUROHPC JU QUANTUM COMPUTING ECOSYSTEM

EuroHPC JU quantum computers offer 650 qubits with six qubit modalities across 10 devices. They integrate with existing HPC centres to make use cases possible through HPC-QC integration.

The EuroHPC JU is building a federated, pan-European quantum computing ecosystem. As highlighted earlier, this aims to make cutting-edge quantum resources widely accessible to users in Europe. The resources offer diverse state-of-the-art qubit modalities to support tailored experimentation across different domains and specific use cases.

EUROHPC JU INTEGRATED QC-HPC INFRASTRUCTURE

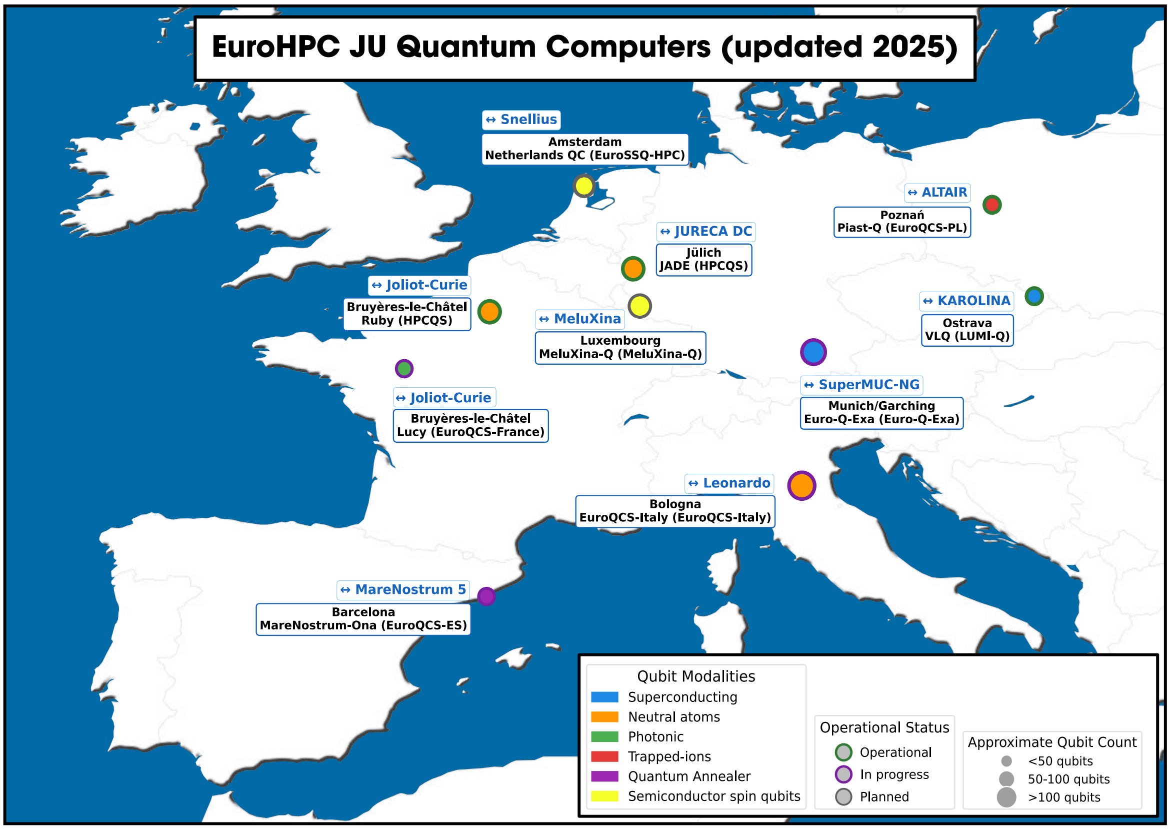
The EuroHPC JU is deploying a portfolio of quantum computers and simulators across Europe, integrated into existing HPC infrastructures. This diversity allows users to explore various qubit modalities, each suited to different algorithms and application areas. SMEs can test and identify the most appropriate technologies with support from NCCs.

A PAN-EUROPEAN QUANTUM COMPUTING NETWORK

By 2025, this initiative aims to provide access to approximately 650 physical qubits across six quantum hardware modalities, engaging 29 partners in 17 European countries. These systems are developed by European companies. The resources provided include quantum hardware, simulators, cloud platforms, and training services.

EIGHT EUROPEAN QUANTUM COMPUTING HUBS

Quantum computers will be hosted in eight countries: Czechia, France, Germany, Italy, Poland, Spain, Luxembourg, and the Netherlands. These systems cover a variety of technologies and are central to the EuroHPC JU ecosystem. The following figure visualises the devices in an infographic.



EUROHPC JU QUANTUM COMPUTERS AND THEIR CONNECTION TO EXISTING SUPERCOMPUTERS

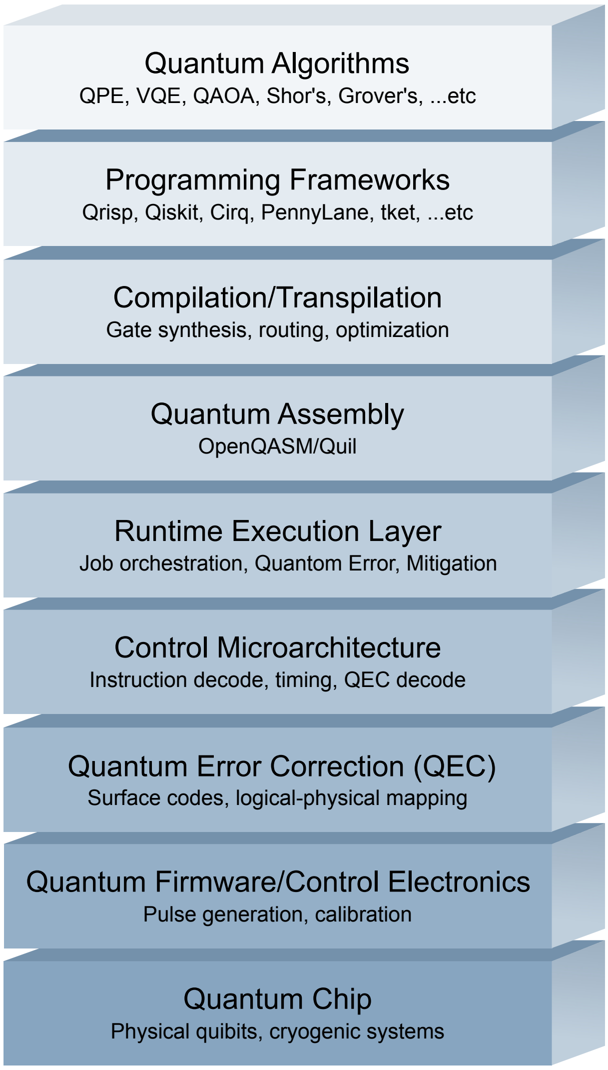
EuroHPC JU enables SMEs to explore the diverse quantum hardware available across Europe and find the right system for their use cases. This variety allows SMEs to experiment with different approaches and identify specific use cases.

The EuroHPC JU is deploying a diverse portfolio of quantum computers across Europe, each connected to powerful supercomputers. This enables hybrid workflows where quantum and classical resources work together. The following table provides an overview of these systems, based on announcements and deployment status as of Q4 2025.

Device name	[Hosting site] Connected HPC	Qubit Modality	Supplier	Primary Focus	Timeline
VLQ	[Ostrova, Czechia] KAROLINA (Czechia) LUMI (Finland) EHPCPL (Poland)	Superconducting 24 quibits, star topology	IQM	Hardware-efficient QEC, QFT, general research & industry applications	Inaugurated Sept 2025
 Lucy	[Bruyéres-le Châtel, France] GENCI Joliot-Curie	Photonic 12 coupler qubits, all-to-all connectivity	Quandela	HPC-QC, meteorology, earth observations, EM and materials simulations	Q4 2025
 Ruby	[Bruyéres-le Châtel, France] TGCC CEA	Neutral atoms 100 qubits	Pasqal	Pharma, energy, logistics, finance, data processing, simulations	Inaugurated Nov 2025
 Jade	[Jülich, Germany] JSC Supercomputing centre	Neutral atoms 100 qubits	Pasqal	Drug design, supply chain, FinTech, chemistry simulations, QML	Inaugurated Nov 2025
 Euro-Q- Exa	[Garching, Germany] JSC Supercomputing Centre	Superconducting 24 qubits (square lattice) 54 then 150 qubits	IQM	Quantum algorithms, industry applications, QEC	System 1 (H2 2025), System 2 (2027)
 EuroQCS-Italy	[Bologna, Italy] Leonardo CINECA	Neutral atoms 140 qubits	Pasqal	Optimisation, ML, quantum chemistry, sophisticated Hamiltonians	~2025-2027
PIAST-Q Piast-Q	[Poznan, Poland] ALTAIR Poznan Supercomputing Centre	Trapped-ions 20 qubits	AQT	HPC-QC, chemistry, optimisation, QML	Inaugurated 2025
 MareNostrum-Ona	[Barcelona, Spain] Barcelona Supercomputing Centre	Superconducting (Annealer) 10, 15, 25 qubits	Qilimanjaro	Optimisation, ML, finance, logistics	To be announced
MELUXINA-Q MeluXina-Q	[Luxembourg] MeluXina Supercomputer	Superconductor spin qubits 10 upgradable to 80 qubits	To be announced	Cybersecurity, finance, general research, industry applications	Installation 2026
EuroSSQ-HPC	[Amsterdam, Netherlands] Snellius Supercomputer SURF	Superconductor spin qubits, 16 qubits initially	Tender closed Oct 2025	Hybrid quantum-classical research, business applications	Installation 2026

THE HYBRID HPC-QC MODEL

Quantum computers need classical computing at every stage of quantum operations. This is why the EuroHPC JU strategy integrates Quantum Processing Units (QPUs) as specialised accelerators alongside CPUs and GPUs, enabling scientists and engineers to use all three in their workflows. The figure illustrates this integration as a software stack connecting user applications to quantum hardware.



FROM ALGORITHM TO HARDWARE

Users write quantum algorithms using high-level frameworks (Qrisp, Qiskit, Cirq), which are then compiled into quantum assembly code (OpenQASM/Quil). The runtime layer manages job execution, while lower layers handle the precise control signals that manipulate physical qubits.

QPUs function as specialised accelerators within classical HPC systems, combining the strengths of both approaches.

NOISE AND ERROR HANDLING

Two techniques address the noise that disrupts quantum calculations:

- Quantum Error Mitigation (QEM) operates at the runtime layer as classical post-processing. After quantum circuits run, classical computers model how noise affected results and estimate what the noise-free answer should be. This requires no extra qubits but has limits as circuits grow larger. Current NISQ (Noisy Intermediate-Scale Quantum) devices rely heavily on QEM.
- Quantum Error Correction (QEC) operates near the hardware level with real-time feedback to physical qubits. It encodes quantum information across multiple qubits to catch and correct errors as they happen, within microseconds. This requires more qubits but scales to larger computations.

PATH TO FAULT-TOLERANCE QUANTUM COMPUTERS (FTQC)

Expected around 2030 based on industry leaders' roadmaps, these systems will require substantial classical computing resources running alongside the QPU to process error correction in real time.

For SMEs, this means today's hybrid HPC-QC skills and workflows will remain relevant as the technology matures. The integration model stays the same, yet the scale and reliability improve.

YOUR GATEWAY TO EUROPEAN QUANTUM RESOURCES

Your local experts in quantum computing: NCCs and QEX.

NCCs and QEX established in EuroHPC JU, serve as key intermediaries and support hubs for users from SMEs and industry. The QEX centre acts as a one-stop shop for quantum computing applications, tools, and specialised trainings. Together, NCCs and QEX offer a broad range of services to help SMEs understand, access, and benefit from the EuroHPC JU quantum ecosystem.

From 2026, the EuroHPC Federation Platform (EFP) will simplify access by providing a unified web portal with single sign-on to all quantum computers, HPC, and AI Factories. Reaching out to NCCs and QEX enables organisations to begin exploring quantum computing without upfront investment, better positioning them to adopt quantum computing as the technology matures.

SMEs can locate their local NCC via the HPC in Europe portal at https://hpc-portal.eu/. The QEX can be reached at https://quantumdelta.nl/qex.

FROM ALGORITHM TO HARDWARE

NCCs and QEX assist SMEs in evaluating their business challenges to identify relevant QC applications. They advice on:

- suitable hardware platforms (such as gate-based, annealers, simulators).
- available services within the EuroPC JU ecosystem.
- building HPC-QC workflows.

HARDWARE ACCESS FACILITATION

NCCs and QEX play a key role in guiding SMEs through the process of accessing quantum and classical resources. They offer:

- help to understand the available access modes for hardware/services.
- guides on connecting with relevant stakeholders in the EuroHPC JU.

TECHNICAL SUPPORT

NCCs and QEX experts provide guidance on:

- algorithm selection, getting started with quantum SDKs, and integration of hybrid HPC-QC workflows.
- adopting and co-developing quantum applications.
- keeping SMEs up-to-date on the latest advances in hardware, simulators, and quantum SDKs through newsletters, blog posts and other channels.

TRAINING

- NCCs deliver workshops, webinars and schools to build quantum literacy within SME teams.
- QEX offers specialised training programmes to build a highly skilled quantum computing workforce across Europe.

Both initiatives ensure SMEs have access to learning opportunities at every level.

PILOT PROJECTS

- QEX acts as a one-stop shop for quantum computing applications and tools.
- NCCs support SMEs in launching small-scale pilot projects to explore QC and gain hands-on experience.

Both initiatives use EuroPC JU quantum and HPC hardware, classical simulation platforms, and hybrid HPC-QC resources.

YOUR PATH TO QUANTUM READINESS

European SMEs can build quantum expertise now through EuroHPC JU resources with NCCs and QEX support, gaining competitive advantage as the technology matures.

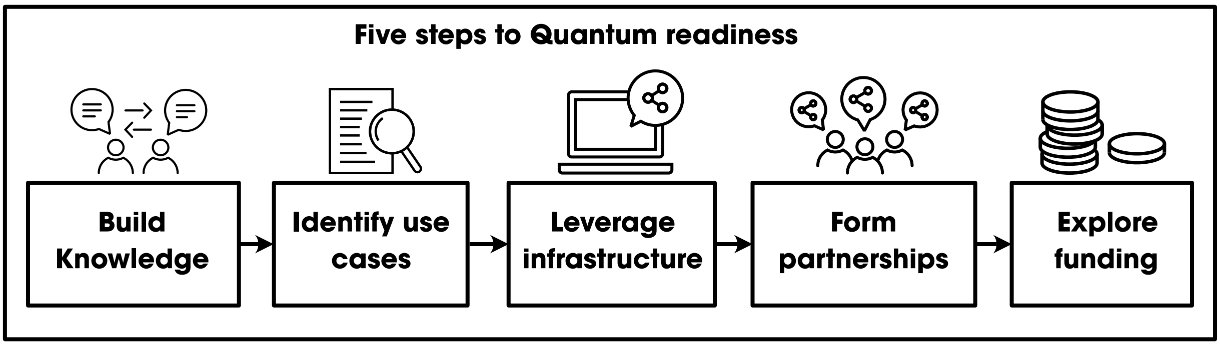
For European SMEs, quantum computing represents a strategic opportunity rather than an immediate investment priority. The technology is still maturing, with practical commercial applications currently limited by hardware constraints. However, SMEs that begin exploring quantum computing now will gain valuable insights and readiness for the technology's future impact on their industries. This early engagement could build a European knowledge advantage and competitive edge as the domain matures.

SMEs already working with advanced computing or those in research-driven fields such as biotechnology, materials science, pharma, chemistry, or finance, are well positioned to explore quantum computing as a strategic path toward future innovation.

FIVE STEPS TO QUANTUM READINESS

With the EuroHPC JU ecosystem, you can follow these steps:

- **Build knowledge** by participating in workshops, webinars, and trainings offered by NCCs and QEX to build foundational knowledge in quantum computing. Hands-on experience with quantum SDKs and EuroHPC JU hardware provides a valuable introduction to quantum principles, algorithms, and practical use cases.
- **Identify relevant use cases** by assessing your business challenges to determine which might benefit from quantum approaches. Focus on areas where classical computation faces limitations. Consult with NCCs and QEX to validate use cases and match them with suitable quantum algorithms.
- **Leverage infrastructure** by taking advantage of EuroHPC JU access calls to gain hands-on experience using HPC resources where you can develop the workflow and simulate it up to hundreds of qubits, then transfer to actual quantum hardware.
- **Form partnerships** by connecting with NCCs and QEX to explore engagement opportunities across the EuroHPC JU quantum landscape. Collaborating with research institutions and other businesses within the ecosystem creates valuable connections that could accelerate quantum adoption.
- **Explore funding** by investigating grants and funding calls, such as those provided by the European Innovation Council (EIC), which has already supported several quantum-focused SME and industry projects.



ASSESSING QUANTUM OPPORTUNITIES TODAY

Quantum computing is powerful but still maturing. SMEs should understand current limitations while using systematic criteria to identify promising use cases.

Before exploring specific industry applications, SMEs need both a clear evaluation framework and realistic expectations about current technology. This section provides criteria for selecting use cases and explains why these criteria matter given the current NISQ hardware.

UNDERSTANDING TODAY'S QUANTUM HARDWARE

The technology is still in the NISQ era, where quantum processors have a limited number of qubits and are susceptible to errors. The EuroHPC JU quantum systems are NISQ devices, generally offering fewer than 1,000 qubits each. This means not every problem is suitable for quantum computing today.

Fault-tolerant quantum computing (FTQC) will need substantial classical resources for running error mitigation and correction codes. All future competitive use cases will necessarily make heavy use of Quantum Error Mitigation (QEM) and Quantum Error Correction (QEC). However, the need for classical computing goes beyond error handling. Quantum computers cannot operate without classical systems that prepare calculations and interpret results. This classical component is often the most resource-intensive part of any quantum workflow. This is why the EuroHPC JU strategy connects quantum computers directly to powerful classical supercomputers (QC-HPC).

THREE CRITERIA FOR EVALUATING USE CASES

Given these realities, SMEs should assess potential quantum use cases against three criteria:

- **Near-term applicability:** Consider use cases suitable for NISQ hardware. Near-term use cases should work with hybrid quantum-classical workflows rather than requiring fault-tolerant systems expected around 2030. NCCs and QEX could help assess whether a specific use case fits current hardware capabilities.
- **Breakthrough potential:** Prioritise use cases that would bring breakthroughs difficult to achieve with classical resources alone. Look for problems where adding more classical computing power yields diminishing returns, or where the time required for classical solutions is simply too long to be practical.
- **Potential return on investment:** Select use cases where quantum computing could generate revenue or cost savings, making early exploration worthwhile. Even modest improvements in areas like logistics routing or production scheduling can translate into significant financial gains.

THE VALUE OF STARTING NOW

Overcoming hardware and algorithmic challenges is key to unlocking the full capabilities of quantum computers. The journey towards robust, fault-tolerant systems is ongoing, but the current EuroHPC JU initiatives allow SMEs to begin exploring, learning, and preparing for future advancements in this transformative field. NCCs and QEX experts can help match business challenges to suitable quantum algorithms and guide technical implementation decisions.

The following section maps these criteria to specific industry applications, showing where quantum computing can address real business challenges today and in the near future.

QUANTUM COMPUTING USE CASES AND ALGORITHMS FOR SME CHALLENGES

From pharmaceuticals to finance: discover which quantum algorithms can solve your industry's toughest computational challenges across seven key business sectors.

Building on the business challenges introduced earlier, this section provides detailed mappings of quantum algorithms to specific industry sectors. Current research highlights several quantum computing use cases likely to offer business value sooner than others. SMEs aiming to achieve quantum readiness should explore use cases that align with their specific business activities and match the evaluation criteria presented in the previous section.

WHERE QUANTUM COMPUTING DELIVERS VALUE: SECTOR-BY-SECTOR APPLICATIONS

This table maps quantum algorithms to specific business problems across **seven key industries**. It shows where quantum computing can address real challenges today and helps you assess where you could utilise quantum capabilities in the near term.

	Molecular & material discovery	Complex optimisation problems	Probabilistic simulation & forecasting	Pattern recognition & predictions	Modeling & simulations	Data security & privacy
Algorithm example	VQE, QPE, SQD	QAOA, QUBO	QMC, QAE	QML, QGAN, QNN	HHL algorithm	PQC Shor's algo
Pharma & life sciences	Drug binding; protein folding; drug design	Clinical trial optimisation	Disease spread prediction	Diagnostics classification; drug response prediction	Protein folding simulations	Patient data privacy (PQC)
Chemicals industry	Reaction pathways; material discovery; catalysts	Production; supply chain optimisation	Simulations of meso-scale reactor processes; yield	Data driven chemical properties predictions	Fluid dynamics in reaction vessels; reation modeling	IPs and trade secrets
Energy sectors	Carbon capture; corrosion inhibition; battery materials; superconductors	Grid optimisation; facility placement; microgrid control	Price forecasting; risk modeling	Renewable energy production predictions; load forecasting	Power routing, distribution calculations; DC power flow in grids	Protecting access to data on grid infrastructure
Telecom	Semiconductor materials	Antenna placement; network routing; beamforming; spectrum allocation	Network stress testing; throughput modeling	Customer segmentation; anomaly detection; network optimisation	EM-field calculations in antenna design	Network data protection
Manufacturing	New materials calculations; composite design	Assembly line production scheduling; supply chain optimisation	Supply chain resilience; quality control simulations	Chip manufacturing fault detection; predictive maintenance	Aerodynamics, structural calculations; materuial stress analysis	Design & comms data protection
Logistics	N/A	Traveling salesman; combinatorial problems; vehicle scheduling	Disruption stress testing; scenario planning	Maintenance prediction; demand forecasting	Inventory management; network flow optimisation	Customer & operational data protection
Finance	N/A	Portfolio optimising; risk management; trading strategy optimisation	Credit VaR; option pricing; Monte Cario simulations for derivative pricing	Fraud detection; credit scoring; market sentiment analysis	Risk estimation; correlation matrix calculations	Transaction & customer data protection

Find your sector and identify the business challenges that match your priorities. Use the evaluation criteria from the previous section to assess which opportunities fit your organisation's readiness. Early exploration builds internal expertise and positions your organisation to capture value as quantum hardware matures.The sectors and applications above represent where that value would emerge.

CONCLUSIONS

Start now, invest later. Gain competitive advantage as the technology matures.

Quantum computing is still emerging, but it holds strong potential for European SMEs tackling complex computational problems or preparing for future technologies. The EuroHPC JU has built a rich ecosystem that lowers entry barriers through access to ten quantum computers offering six qubit modalities, including superconducting, neutral atom, photonic, trapped ion, quantum annealing, and semiconductor spin systems. These systems are integrated with powerful classical supercomputers across eight European countries.

This white paper has highlighted how quantum computing could support SME needs across different business areas and industry sectors. SMEs can start preparing now without major investment in hardware by building foundational knowledge through training, identifying relevant use cases, leveraging EuroHPC JU infrastructure, forming partnerships, and exploring funding opportunities. National Competence Centres and the Quantum Excellence Centre offer expert guidance, technical support, and training to help SMEs move from curiosity to practical experimentation. From 2026, the EuroHPC Federation Platform will simplify access further by providing a single portal to all quantum computers, supercomputers, and AI Factories.

SMEs already working with advanced computing or research-driven fields are well positioned to explore quantum computing as a strategic path toward future innovation. By engaging early, experimenting with available tools, and building internal expertise, SMEs can gain a competitive edge as the technology matures and becomes more widely adopted.

ACKNOWLEDGEMENTS

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APPENDIX A: GLOSSARY

- **Qubit (quantum bit):** the basic unit of quantum information. Unlike classical bits (0 or 1), qubits can represent 0, 1, or a combination of both (superposition).
- **Superposition:** a fundamental principle of quantum mechanics where a quantum system (like a qubit) can be in multiple states at the same time until measured.
- **Entanglement:** a quantum phenomenon where two or more qubits become linked in such a way that their states are connected, regardless of the distance separating them. Measuring the state of one entangled qubit immediately reveals information about the state of the other(s).
- **Quantum algorithm:** a set of instructions designed to be run on a quantum computer and natively use quantum phenomena like superposition and entanglement to solve specific types of problems more efficiently than classical algorithms.
- **Gate-based quantum computer:** a type of quantum computer that uses quantum logic gates (analogous to classical logic gates) to perform operations on qubits. This is a common model for universal quantum computation.
- **Quantum annealing:** a type of quantum computation particularly suited for solving optimisation problems. It works by physically evolving a quantum system towards its lowest energy state, which corresponds to the optimal solution of the problem.
- **Superconducting qubit:** a type of qubit based on superconducting electronic circuits, which must be operated at extremely low temperatures.
- **Photonic quantum computer:** a quantum computer that uses photons (particles of light) as qubits.
- **Neutral atom quantum computer:** a quantum computer that uses individual neutral atoms, precisely controlled by lasers, as qubits.
- **Trapped-ion quantum computer:** a quantum computer that uses ions (electrically charged atoms), confined by electromagnetic fields and manipulated by lasers, as qubits.
- **Semiconductor spin qubit:** a type of qubit that uses the spin state of electrons in semiconductor materials, similar to traditional computer chips.
- **QPU (Quantum Processing Unit):** the hardware component that contains and controls qubits in a quantum computer.
- **NISQ (Noisy Intermediate-Scale Quantum):** refers to the current era of quantum computers, which have a limited number (typically 50 to 1000 qubits) that are prone to noise and errors, and lack full fault tolerance.
- **FTQC (Fault-Tolerant Quantum Computing):** future quantum computers capable of correcting errors automatically, enabling reliable large-scale calculations. Expected around 2030.
- **HPC (High Performance Computing):** the use of supercomputers and parallel processing techniques for solving complex computational problems.
- **Quantum simulator:** it can be either (1) a special-purpose quantum device to model and simulate other quantum systems, often too complex for classical computers; or (2) classical software that simulates the behaviour of a quantum computer (on a limited scale) using SDKs like Qrisp, Qiskit, Cirq, etc.
- **NCC (National Competence Centre):** national organisations in the EuroCC network providing expertise, training, and facilitating access to HPC resources for SMEs and industry.
- **QEX (Quantum Excellence Centre):** a European centre offering specialised quantum computing applications, tools, and training for SMEs and industry.

APPENDIX B: RELATED RESOURCES AND FURTHER READS

EuroHPC JU Resources

- EuroHPC JU website: https://eurohpc-ju.europa.eu
- EuroHPC JU quantum computers overview: https://eurohpc-ju.europa.eu/eurohpc-quantum-computers/our-quantum-computers_en
- Access to resources: https://www.eurohpc-ju.europa.eu/supercomputers/supercomputers-access-calls_en
- EFP EuroHPC Federation Platform: https://my-eurohpc.eu/

Support and Access Points

- Quantum Excellence Centre (QEX): https://quantumdelta.nl/qex
- EuroCC Access Portal (to find your NCC): https://www.eurocc-access.eu
- AI Factories access calls: https://mimer-ai.eu/#ai-access-calls

European Quantum Initiatives and Projects

- European Quantum Flagship: https://qt.eu
- European Quantum Industry Consortium (QuIC): https://www.euroquic.org
- HPCQS Project: https://hpcqs.eu/

Centres Hosting EuroHPC Quantum Computers

- LRZ (Germany - Euro-Q-Exa): https://www.lrz.de
- IT4Innovations (Czechia - LUMI-Q/VLQ): https://www.it4i.cz/en
- CINECA (Italy - EuroQCS-Italy): https://www.cineca.it/en
- PSNC (Poland - Piast-Q): https://www.psnc.pl
- GENCI (France - Lucy & Ruby): https://www.genci.fr/en
- BSC (Spain - MareNostrum-Ona): https://www.bsc.es
- LuxProvide (Luxembourg - MeluXina-Q): https://www.luxprovide.lu
- SURF (Netherlands - Netherlands QC): https://www.surf.nl/en

EuroHPC JU Quantum Hardware Vendors

- IQM Quantum Computers: https://meetiqm.com
- Pasqal: https://www.pasqal.com
- Quandela: https://www.quandela.com
- AQT: https://www.aqt.eu
- Qilimanjaro: https://qilimanjaro.tech

Quantum Programming Frameworks

- Qrisp: https://www.qrisp.eu/
- Qiskit: https://qiskit.org
- Cirq: https://quantumai.google/cirq
- PennyLane: https://pennylane.ai

Software Tools

- EESSI European Environment for Scientific Software Installations: https://www.eessi.io
- Curated list of open-source quantum software projects: https://github.com/qosf/awesome-quantum-software

Learning Resources

- A light introduction to quantum computing and quantum mechanics: https://quantum.country/
- Quantum algorithms for different use cases with implementations: https://quantumalgorithmzoo.org
- Quantum algorithms for data analysis: https://quantumalgorithms.org

Training

- ENCCS Quantum Autumn School 2025: https://enccs.github.io/qas2025
- ENCCS Quantum Autumn School 2024: https://enccs.github.io/qas2024
- ENCCS Quantum Autumn School 2023: https://enccs.github.io/qas2023
- ENCCS lessons: https://enccs.se/lessons

Community and Networking

- Unitary Fund: https://unitary.foundation/
- QOSF (Quantum Open Source Foundation): https://qosf.org/

News and Updates

- The Quantum Insider: https://thequantuminsider.com/
- Quantum Zeitgeist: https://quantumzeitgeist.com/

Funding Opportunities

- European Innovation Council (EIC): https://eic.ec.europa.eu
- EU Quantum Technologies strategy: https://digital-strategy.ec.europa.eu/en/policies/quantum-technologies
- Digital Europe Programme: https://digital-strategy.ec.europa.eu/en/activities/digital-programme