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# White paper on quantum computer use ethics

## Quantum Computing Access Policy: Value-Led Recommendations for the Future of the EU

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## Executive summary

This white paper advances fifteen policy recommendations for allocating access to quantum computing resources in the EU. These recommendations are the result of an effort by OpenSuperQPlus, a Horizon Europe-funded programme to develop a large-scale quantum computer based on superconductor technology for the EU. Anticipating the successes of this and other EU efforts, OpenSuperQPlus has taken responsibility for initiating an urgent conversation about the allocation of the quantum computation time made available by the first generations of quantum computers within the borders of the EU.

The position developed in this white paper is that the EU should govern access to its quantum computing resources on the basis of its founding values, as applied and interpreted in the context of current geopolitical realities.

The fifteen recommendations are extensively introduced and motivated at the end of the white paper and briefly described in a box in this summary. Three overarching themes cut across the recommendations:

1. The EU should build strong European *quantum computing communities of practice*, transdisciplinary communities of early users who can collaboratively explore future applications and unlock the exploitable functionality of quantum computing for industry and society.
2. The EU should *reduce barriers to meaningful access* to European quantum computing.
3. The EU should *embed its founding values* into the governance of quantum computing.

Additional highlights are:

- A description of the relevant EU values for quantum computing access;
- A presentation of the views and needs of Europe's quantum computing "frontrunners";
- A sketch of the "space of policy options" available to policymakers formulating access policy for quantum computing;
- The insight that the first generations of quantum computers already show promise for demonstrating quantum advantage over digital computers for specific computational tasks relevant for the EU's aims and goals.

We submit these recommendations to the European Commission, EuroHPC JU, and policymakers of the Member States. Policies for quantum computing are currently being rapidly developed through the emergence of new and renewed national strategies for quantum technologies, updates to the EU Quantum Flagship's *Strategic Research and Industry Agenda* (SRIA), the incorporation of quantum computing into EuroHPC JU, and the upcoming EU Quantum Act. Adopting these recommendations will enable future EU policies regarding access to its quantum computing resources to remain in sync with the values of the EU.

**Fifteen recommendations**

These recommendations are organised along five distinct "dimensions": (1) who receives access; (2) what access is used for; (3) why access is granted; (4) where access takes place; and (5) how access is facilitated.

***Who-dimension recommendations***

**1.1. Facilitate access to quantum computing to all in the EU**
The EU should facilitate centralised, cross-border access to quantum computing for scientific, industrial, and societal actors across all sectors.

**1.2. Create public access to quantum computing**
The EU should widen access to quantum computing to the public, reserving meaningful capacity for free, open use.

**1.3. Give commercially and socially strategic global access to quantum computing**
The EU should facilitate targeted global access to its quantum computing infrastructure where this advances the aims of the EU within its borders and supports the realisation of the values and aims of the EU in the wider world.

***What-dimension recommendations***

**2.1. Cultivate quantum computing communities of practice**
The EU should build resilient communities of practice that spread quantum computing knowledge and expertise across institutions, sectors, and regions.

**2.2. Offer access combining multiple quantum computing facilities**
Access should be provided combining multiple EU quantum computing facilities, enabling comparison and developing cross-facility expertise.

**2.3. Prioritise application of promising early use cases**
EU access policy should realistically prioritise promising early use cases with potential for near-term quantum advantage and the development of intellectual property.

***Why-dimension recommendations***

**3.1. Prioritise the realisation of EU's values with quantum computing**
The EU should meaningfully apply its founding values as criteria for determining priorities for investment in and allocation of quantum computing resources.

**3.2. Establish knowledge centres for early use cases of quantum computing**
The EU should establish transdisciplinary knowledge centres to collect, develop, and disseminate quantum computing applications and use cases.

**3.3. Foster accountability and mitigate misuse of quantum computing**
The EU should develop early regulatory and institutional safeguards against harmful uses of quantum computing.

***Where-dimension recommendations***

**4.1. Enable upgrading of quantum computing hardware**
EU procurement and manufacturing should support upgrade pathways, modular replacement, and leasing arrangements for quantum computing hardware.

**4.2. Transparent access rules for quantum computing**
Information about available quantum computing resources, eligibility, application procedures, and selection criteria should be publicly available and easy to understand.

**4.3. Facilitate secure and equitable remote access to quantum computing**
The EU should establish, and develop where necessary, infrastructure enabling secure and equitable remote access to quantum computing across all Member States.

***How-dimension recommendations***

**5.1. Support interoperable software for quantum computing**
Quantum software should support interoperability across different quantum architectures wherever possible, enabling users to move between platforms more easily.

**5.2. Introduce a dedicated emulator access track for training and validation**
The EU should introduce a dedicated emulator access track to support training, benchmarking, and development before users access scarce quantum hardware.

**5.3. Develop a "service stack" for quantum computing access**
Layered access, from direct qubit manipulation, access through middleware, to provider-mediated services, should be offered to users according to their needs and expertise.

Readers interested primarily in policy recommendations may wish to proceed directly to Section 8: Value-Led Recommendations for EU Access to QC.

The remainder of the document is ordered as follows. In Section 2: Taking Stock, the backdrop of existing EuroHPC access policy is described, and along with its underlying values. In Section 3: Taking Aim, the EU's strategic aims for QC are surveyed. In Section 4: Taking Inspiration, leading international perspectives on the question of allocating access to QC are introduced. In Section 5: Taking the Lead, the results of the OpenSuperQPlus consultation with Europe's leading QC experts and early adopters are presented. In Section 6: Taking Responsibility, the case is made for consistently enacting the EU's founding values and aims – including global values and aims – in any future EU access policy for QC. In Section 7: Taking Shape, a multidimensional "policy space" for QC access is mapped, allowing readers to focus on those aspects of access most relevant to their interests.

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# 1. Introduction

The EU is substantially investing in the development of quantum computers through national and federal efforts. These efforts are proving successful and are on track to make available a stock of prototype quantum computers. As a result of this success, the EU must consider a number of policy challenges, including how to shape the next phases of development of quantum computers, how to give users access to the prototype quantum computers, and how to create the infrastructure to scale up the manufacturing of quantum computers. OpenSuperQPlus is one of the EU's programmes dedicated to developing quantum computers and it has taken up responsibility for thinking about these upcoming policy challenges. This white paper is the result of this commitment and arrives at fifteen recommendations for EU policy for giving access to quantum computing.

Policies for quantum computing (QC) are currently in rapid development by various initiatives ranging from the emergence of new and renewed national strategies for quantum technologies, updating of the EU Quantum Flagship's *Strategic Research and Industry Agenda* (SRIA), and the upcoming EU Quantum Act. One of these developments has been to include quantum computing in the European Union under the mandate of the *European High Performance Computing Joint Undertaking* (EuroHPC JU). EuroHPC JU has well-developed access policies for classical computational resources, giving in principle a clear basis for access policy for QC. EuroHPC JU has, however, temporarily suspended the application of its existing policies to QC, in order to explore how to adapt and extend its existing policy to QC in the near future.

This white paper advances the position that the EU should do so on the basis of its founding values. Current policy debates surrounding quantum computing frame the technology in terms of the EU's economic competitiveness, scientific excellence, or strategic advantage. These objectives matter, but quantum computing can also be developed in ways that promote values such as fairness, transparency, solidarity, public trust, sustainability, and the broader public good.

The discussion that follows considers how access to quantum computing can be organised in ways that reflect these values while supporting the development of autonomous, efficacious, and resilient EU quantum computing communities of practice. It addresses not only which users should receive access, but also what technical, societal, and regulatory conditions must be in place for access to quantum computing to meaningfully contribute to important non-strategic EU values.

This discussion is organised in seven steps. Sections 2 to 4 establish the relevant background for thinking about EU access to QC. First, Section 2: Taking Stock analyses the existing access policy of EuroHPC JU. Second, Section 3: Taking Aim explores the strategic ambitions of the EU for QC. Third, Section 4: Taking Inspiration looks beyond the EU and sketches global and multilateral perspectives on QC. Sections 2 to 4 each close with a set of questions intended to advance the conversation surrounding access to QC within the EU. The questions presented are intended to challenge assumptions prevalent in current thinking around QC access.

Set against this background, Sections 5 to 8 motivate fifteen concrete proposals for EU access to QC. To better understand the practical requirements for a future EU QC access policy, OpenSuperQPlus has undertaken a consultation with current and prospective users of European QC resources from research, industry and public sector institutes. Hence, Section 5: Taking the Lead presents the results of this consultation. Fifth, Section 6: Taking Responsibility brings together EU values that are relevant for QC access policy. These values include those already

central in current policy debates regarding quantum computing, but also other values that define the political foundations of the European Union. Section 7: Taking Shape maps the "policy space" for defining a future EU QC access policy. Finally, Section 8: Value-Led Recommendations for EU Access to QC proposes fifteen recommendations for an EU access policy for QC, drawing on the findings of the earlier sections.

| **Box 1: Glossary of key terms** | |
|---|---|
| Communities of practice | Demographically, geographically, organisationally, and disciplinarily diverse networks of collaboration, through which QC knowledge and expertise can diffuse and become institutionally secured. |
| Global values | Values whose scope extends to all groups and geographical regions. |
| Regional values | Values whose scope does not extend beyond members of certain groups and/or geographical borders. |
| Early quantum champions | Researchers and professionals who already work directly with quantum hardware and software to develop applications and advance technical knowledge. |
| Early quantum adopters | Organisations and institutions seeking to incorporate quantum computing into their activities without necessarily developing detailed in-house expertise in the underlying technology. |
| Humanware | Collaborative teams mediating between quantum hardware and non-expert end-users, capable of accumulating, retaining, and sharing practical knowledge and experience across time. |
| Middleware | User-friendly software for unlocking the exploitable functionality of quantum hardware without requiring deep technical knowledge. |

# 2. Taking Stock: Current EuroHPC regulation

Any future access policy for QC within the EU will be modelled on and influenced by existing regulation governing access to antecedent advanced computational resources, like classical High-Performance Computing (HPC). In the EU, access to public HPC infrastructure is facilitated by the European High Performance Computing Joint Undertaking (EuroHPC JU).[3] EU QC infrastructure will now also become part of EuroHPC JU.[4] The emergence of publicly managed QC capacity in the EU therefore represents an opportunity to reflect on the suitability of existing EuroHPC JU access policy for the integration of QC and provides a starting point for constructing actionable recommendations about QC access.

## *EuroHPC access*

The primary, explicit aim of the EuroHPC Access Policy[5] is to distribute access to the limited public HPC capacity in the EU in a way that generates the best possible returns on EU investment in its public HPC infrastructure. Return on investment here is understood broadly to include economic value as well as social values, such as health and security, and scientific values, such as knowledge and skills. The aim of maximum-value-for-money is reflected in the emphasis placed on excellence in the criteria for evaluating proposals.

This focus on return on investment is also reflected in the state-based eligibility criteria for users: access is limited to users located in EU Member States or in states associated with and contributing financially to relevant EU programmes such as Horizon Europe[6] or the Digital Europe Programme (DEP).[7] Broader international cooperation is possible, but it is explicitly governed by a principle of like-for-like reciprocity: access granted to external users must be matched by equivalent access to their computing systems.

The EuroHPC access policy constrains access in ways that reflect a commitment to other values, including trust and open science. For example, all users are required to conform to existing ethical standards on use of AI as laid out in relevant EU legislation, such as the AI Act,[8] which prescribes ethical principles for trustworthy AI.[9] Conformity is checked as part of the administrative assessment of all proposals, prior to any technical assessment or peer review. A detailed plan for dissemination of results must be submitted with the project proposal. All users benefitting from free-to-use access (except for SMEs undertaking proprietary research) are obligated to adopt an open science approach, making the results of their access publicly available.

All proposals are evaluated prior to peer review based on the methodological and technical feasibility of the allocated HPC resources for achieving the aims of the project, as judged by operational experts from the relevant Hosting Entities, the institutions responsible for maintaining and managing the computers procured by EuroHPC. All large-scale proposals for access to EuroHPC resources are required to have undergone preliminary benchmarking, based on which the relevant Hosting Entity will judge the technical feasibility of the full application. This

[3] https://www.eurohpc-ju.europa.eu/index_en
[4] https://www.eurohpc-ju.europa.eu/eurohpc-jus-mandate-expanded-under-new-regulation-amendment-2026-01-20_en https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32026R0150&qid=1652430268150
[5] https://www.eurohpc-ju.europa.eu/document/30614065-6dd6-4206-8065-fc97948e5e2c_en
[6] https://commission.europa.eu/funding-and-tenders/find-funding/eu-funding-programmes/horizon-europe_en
[7] https://commission.europa.eu/funding-and-tenders/find-funding/eu-funding-programmes/digital-europe-programme_en
[8] https://eur-lex.europa.eu/eli/reg/2024/1689/oj/eng
[9] https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

is facilitated through dedicated "Benchmark" and "Development" access modes, which are specifically devoted to facilitating and accelerating small-scale preliminary inquiries into the technical feasibility of an intended application of EuroHPC resources. Benchmark access focuses on the collection of performance data for proposed applications, while Development access focuses on code and algorithm validation; up to 5% of total HPC access is dedicated to each of these preliminary access modes. This requirement ensures that HPC resources get allocated to the projects capable of using them most effectively, reflecting the priority of value-for-money for EU investments.

At the peer review stage, the primary determining factor for allocating access to EuroHPC resources is *excellence*. Excellence is defined differently depending on the prospective user. Users are divided into three different "tracks": an industrial track, a public sector track, and a scientific track.

- For proposals from industry, excellence is conceptualised pragmatically in terms of potential contribution to the EU's economic competitiveness and innovativeness, as well as industrial relevance for the participating Member States.
- For public sector proposals, public relevance and socio-economic impact for participating Member States is emphasised.
- Lastly, for scientific proposals, scientific excellence is prioritised, as scored by independent external expert peer-reviewers. Potential for domestic and international scientific impact is singled out as a key assessment criterion.

Access to EuroHPC resources is allocated to the highest-ranked proposals until the available resources are exhausted.

Successful applicants are expected to produce a detailed report of how exactly they made use of the access time they received within three months of receiving it, including details of the energy use and carbon footprint of the project, and to provide an up-to-date list of publications arising from the use of EuroHPC resources for up to two years after receiving access.

In some circumstances, the peer review process can be bypassed. First, access to up to 20% of total capacity is granted to commercial users on a pay-per-use basis. Commercial users of EuroHPC resources must sign an acceptable use policy before they are granted access. Second, the EU can designate certain initiatives as strategically important and grant them direct access to up to 10% of the total HPC resources, bypassing the normal peer-review process. The only time this bypass has ever been used is Decision No 30/2022,[10] when the Governing Director of EuroHPC endorsed the designation of 5% of EuroHPC resources to Destination Earth (DestinE),[11] an initiative aiming "to model, monitor and simulate natural phenomena, hazards and the related human activities", on the basis of its strategic significance for the EU. Last, in urgent situations, such as health crises, climate emergencies, or security threats, the EU may commandeer an unlimited amount of public HPC resources for critical applications. Emergency requests are evaluated rapidly by the Executive Director of the JU, and hosting centres are required to provide resources at short notice. This provision has never been used.

The EuroHPC access policy invites several questions, some of which are listed in Box 2. The question central to this white paper is how this policy should be translated to the QC domain.

[10] https://www.eurohpc-ju.europa.eu/system/files/2022-11/Decision%2030.2022_GB%20Special%20Access%20DesEarth.pdf
[11] https://destination-earth.eu/

**Box 2: Open questions regarding current regulation:**

- Is the reciprocal approach to global access to EuroHPC resources fully congruent with the EU's more ambitious aims in the wider world, such as sustainable global development, the eradication of global poverty, and the protection of human rights worldwide?
- Emphasis on excellence may exclude less experienced, under-resourced users in favour of more experienced, already well-resourced users. Such exclusion may exacerbate digital divides. Is this compatible with the EU's expressed aim of combatting social exclusion and discrimination?
- Is siloing the different values underlying access to EuroHPC resources into different access tracks the optimal strategy for pursuing the EU's aims, such as solidarity within its borders, which may be based upon shared or overarching values and aims?
- Successful applicants are expected to assess the carbon footprint of their usage of EuroHPC resources after the fact. Is this ex-post approach the most effective way of ensuring sustainable use of EuroHPC resources?
- The EU considers climate modelling of sufficient strategic importance to designate 5% of total EuroHPC resources to the task. However, this mechanism makes strategically important applications the exception rather than the rule. Why not utilise other prioritisation mechanisms, such as themed calls, to steer public use of EuroHPC resources towards the EU's societal and strategic interests by default?

### *The quantum anomaly: pilot QC access*

Initially, all access to EuroHPC QC capacity will be allocated via a "Pilot Access" mode, devoted specifically to developing and testing applications of the various QC modalities that will be available through EuroHPC. Proposals are subject solely to eligibility and feasibility checks and are not peer-reviewed; access is allocated on a first-come, first-served basis. Industrial, public sector, and scientific proposals are all assessed in the same way.

Because the full industrial, social, and scientific value of QC remains unknown, this mode of access to QC capacity is intended to encourage experimentation. Data from the Pilot Access mode will be fed back into future QC access policy. The freedom of this exploratory phase provides a sandbox for thinking about future access; *policy* experimentation as well as technical experimentation. For example, how could future access to EuroHPC QC capacity support the full spectrum of Europe's economic, strategic, and social goals?

While building on existing EuroHPC access policy, any future access policy for EU QC resources will be driven by the EU's stated strategic and societal ambitions for QC, as informed, for example, by the *Draghi Report*,[12] the *Niinistö Report*,[13] the *European Economic Security Strategy*,[14] the *EU Declaration on Quantum Technologies*,[15] and the *European Quantum Strategy*,[16] among others. The emergence of publicly managed QC infrastructure in the EU therefore provides an opportunity to consider the suitability of current regulation models for promoting the EU's societal and strategic goals for QC, as well as how and whether these goals can be mutually operationalised in practice.

[12] https://commission.europa.eu/topics/competitiveness/draghi-report_en
[13] https://commission.europa.eu/document/5bb2881f-9e29-42f2-8b77-8739b19d047c_en
[14] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52023JC0020
[15] https://digital-strategy.ec.europa.eu/en/library/european-declaration-quantum-technologies
[16] https://digital-strategy.ec.europa.eu/en/library/quantum-europe-strategy

# 3. Taking Aim: The EU's QC ambitions

QC is viewed by the EU as both a critical "sovereignty technology" and a driver of future economic growth. In response, the EU is pursuing policies geared towards its own technological and economic sovereignty. This is to be achieved through establishing a foundation of QC expertise within the EU and a unified regulatory environment conducive to translating this expertise into profitable QC applications.

## *QC as a "critical technology"*

As the result of ongoing geopolitical developments, current EU policy around QC reflects a shift in discourse in which issues of competitiveness and security have become entangled. The fact that QC is implicated in both aims is reflected in the inclusion of quantum technologies on the EU's list of critical technologies,[17] alongside advanced semiconductors, artificial intelligence, and biotechnologies. These technologies are potentially transformative for the EU economy while at the same time posing societal and material risks for Europe. In particular, QC may one day be able to simulate important properties of complex chemical reactions, composite materials, and fluid systems, with high-impact pharmaceutical and engineering applications; and they may one day be able to solve complex optimisation problems, resulting in more efficient supply chains and energy grids. At the same time, they may one day be able to decrypt states' and citizens' private RSA-encrypted communications, and act as a source of new methods for state repression and enhanced warfare. This "dual use" nature of quantum computing is reflected in the coverage of (components of) quantum technologies under evolving export control regimes, such as the Wassenaar Arrangement,[18] which place legal limits on the accessibility of quantum computing to users beyond the parties to such agreements (Quantum Strategy Institute, 2025). There is therefore a tension between embracing the transformative potential of QC for European society while avoiding their use for invasive, aggressive, or oppressive purposes.

In parallel, the *European Economic Security Strategy* argues that rising geopolitical tensions have transformed global economic and technological interdependencies into security vulnerabilities.[19] The *European Declaration on Quantum Technologies* therefore explicitly links QC development to EU technological sovereignty and geopolitical autonomy, arguing that the EU must build its own domestic capabilities across "the entire quantum stack" to avoid strategic dependence on non-EU suppliers. Similarly, the *Quantum Europe Strategy* frames investments in all aspects of QC development as necessary for safeguarding the EU's long-term capacity to develop and utilise QC independently and in its own interests. The need to develop domestic quantum computing capabilities in the EU is a significant factor in developing a future EU quantum computing access policy: if such access policy is ineffective and insufficiently tailored to the needs of its intended users, then these users will just get their access to quantum computing resources from elsewhere – typically US "giants" like IBM and Google – perpetuating US dominance in quantum computing and maintaining a source of geopolitical leverage.

Alongside the need for technological sovereignty to avoid exposure to economic shocks and coercion, there is a perceived need to address the possibility that technologies developed in EU

[17] https://eur-lex.europa.eu/eli/reco/2023/2113/oj/eng
[18] https://www.wassenaar.org/
[19] The EU's reliance on increasingly unstable global supply chains – including for the materials and components upon which QC relies – exposes the EU to potential economic shocks as well as to economic coercion. The *Draghi Report* notes that "[f]or quantum computing platforms, the EU suffers from six critical dependencies across 17 key technologies, components and materials. China and the US hold technological leadership in most of these critical elements" (2025b, p. 57).

are used directly for harm within and against EU Member States and citizens. The *Niinistö Report* emphasises the need "to safeguard knowledge and innovation by countering Intellectual Property (IP) and technology leakages to malicious actors, especially in sensitive areas" (2024b, p. 108), singling out quantum alongside other technologies recognised as critical. At the same time, in their report on the impact of quantum computing and quantum technologies on law enforcement,[20] Europol has drawn attention to how criminals might use quantum computing[21] to access encrypted data and guess passwords, rendering the European public vulnerable to new forms of extortion and exploitation, such as ransom demands, social engineering, and phishing. These same QC-enabled abilities may give law enforcement an edge, for example, in their "investigations of child sexual abuse and exploitation, which has an important digital component, or terrorism, which is often extremely time sensitive and, as such, requires efficient investigation measures" (2023, p. 18). The relevance of these possibilities for future access policies for European QC is explored further in Box 3.

**Box 3: QC for law enforcement: the perspective of Europol[22]**

*"Building on Europol's ongoing exploration of quantum technologies and their implications for law enforcement, it is clear that quantum computing will have a significant impact on the EU's internal security landscape. As Europe moves towards more operational quantum computing capabilities, it will be critical that law enforcement agencies are included among the first institutional users.*

*Early access to European quantum computing resources would enable Europol and its partners to strengthen their preparedness for emerging threats, particularly those arising from the potential misuse of quantum technologies by organised crime and other malicious actors. At the same time, it would support the responsible development of new analytical and investigative capabilities, ensuring that the benefits of quantum innovation contribute directly to increasing the internal security of the European Union.*

*From a governance perspective, Europol stands ready to contribute its expertise and operational insights to the development of frameworks that ensure the secure and ethical use of quantum computing. Such engagement would help safeguard European technological leadership while ensuring that law enforcement remains capable of keeping the EU safe in the quantum era.*

*Europol would welcome further dialogue with the European Commission and other stakeholders to define practical arrangements for early law enforcement engagement in the first allocation of European quantum computing capacity."*

*Europol*

The recognised possibility for malicious use of QC creates a need for anticipatory regulation of how QC is used and by whom, including through any future EU access policy for QC. However, such anticipatory regulation runs up against an alternative vision of the future of QC in the EU.

### *The EU as the "Quantum Valley of the world"*

The negative policy framing of QC as a "critical technology" stands in contrast to the positive framing of QC as a future driver of prosperity within the EU. The *Draghi Report* identifies advanced

[20] https://www.europol.europa.eu/media-press/newsroom/news/exploring-second-quantum-revolution-new-report
[21] By applying the Shor and Grover algorithms.
[22] This text was provided by Europol as a summary of their current views.

digital technologies as an essential future "growth engine" for the EU, and highlights QC as a likely successor to previous digital revolutions. While the EU is perceived to have failed to capitalise on the dot com and AI revolutions, the second quantum revolution represents an opportunity for the EU to reposition itself alongside the US and China as a global centre of technological innovation. This opportunity motivates the stated aim of the *Declaration on Quantum Technologies*

> to create a globally competitive ecosystem that can support a wide range of scientific and industrial applications, identify the industrial sectors where quantum technologies will have high economic and societal impact, and foster quantum innovation in small and large companies alike, from promising start-ups and scale-ups to major industrial players – in short, to become the *'quantum valley'* of the world. (2023, p. 2)

Becoming the "quantum valley" of the world will require the EU to effectively capitalise on its longstanding status as a world-leader in cutting-edge fundamental science and technology, translating academic expertise into commercialisation. Two main obstacles have been identified as standing in the way of this goal and have been targeted by recent policy interventions. These are highly relevant to any future EU QC access policy.

First, while the EU produces more graduates in QC-related fields relative to its population than anywhere else in the world, it is recognised that there is a deficit in the number of professionals possessing the right combination of QC-relevant knowledge and skills necessary for the commercialisation of QC technology. Addressing this deficit has become a policy priority for the EU. Such QC-relevant knowledge and skills and their interconnections have been comprehensively mapped by Quantum Technology Education Coordination and Support Action (QTEdu CSA)[23] in their *European Competence Framework for Quantum Technologies*.[24] On this basis, QTEdu facilitates numerous educational courses and programmes at all levels intended to bring together academic expertise and industrial applications.[25] In parallel, the Digital Europe Programme offers training opportunities such as the "Digitally enhanced Quantum Technology Master" (DigiQ)[26] and "Quantum Technology Courses for Industry" (QTIndu).[27] Alongside other digital technologies on the EU's critical technologies list, the Digital Europe Programme has launched a "Quantum Digital Skills Academy."[28]

According to the call for proposals issued by the European Commission,[29] the Quantum Digital Skills Academy

> will serve as a single, central entity providing specialised quantum technologies training and hands on experience at different levels, and will play an important role in contributing to the objectives of the *European Declaration on Quantum Technologies* in the domain of quantum skills development and training.

These educational initiatives are welcome. However, they should be complemented with the *appropriate kinds of access* for developing hands-on QC expertise. Moreover, such access should be tailored towards developing the *right kind of QC expertise* – the kind of expertise that

[23] https://qtedu.eu/
[24] https://op.europa.eu/en/publication-detail/-/publication/bbf03156-1684-11f0-b1a3-01aa75ed71a1/language-en
[25] https://qtedu.eu/programs-courses-and-trainings/lifelong-learning-and-retraining
[26] https://digiq.hybridintelligence.eu/
[27] https://qtindu.eu/
[28] https://digital-skills-jobs.europa.eu/en/latest/news/eu-launches-digital-skills-academies-bridge-critical-talent-gaps-key-technological
[29] https://pact-for-skills.ec.europa.eu/stakeholders-and-business/funding-opportunities/sectoral-digital-skills-academies-quantum-skills-digital-academy_en

corresponds directly to the needs of the EU's "early quantum champions" and "early quantum adopters" (see Section 5: Taking the Lead).

A second obstacle to realising the EU's ambition to become the "quantum valley" of the world is the national and regional fragmentation of various aspects of its QC ecosystem, including funding, regulation, and – most importantly for our purposes – access. This is reflected in the *Quantum Europe Strategy*, which notes that "insufficient coordination has led to duplication of efforts, inefficient use of resources, and growing competition for talent" which limit "the development of a globally competitive European industrial capacity and a unified European quantum market" (2025a, p. 2). Fragmentation has been identified by the European Quantum Industry Consortium (QuIC)[30] as a fundamental obstacle to cross-border expansion of European QC start-ups into globally successful QC companies, noting in their white paper in response to the call for evidence on the EU Quantum Act[31] that, as a result of fragmented funding and oversight processes, approval times for cross-border industrial QC projects take "up to a year compared to weeks in the U.S." (2025, p. 11).

Recent policy interventions have sought to address the issue of fragmentation. Following an open call, the EuroHPC JU has recently selected a proposal for a new Centre for Quantum Excellence (QEX), which "will act as a one-stop shop for quantum computing applications and tools, empowering European scientific users, businesses, and industry to harness the power of quantum technologies."[32,33] QEX is explicitly positioned as a centralised hub for researchers and end-users across the EU to access open-science resources through the European Open Science Cloud (EOSC)[34] as well as European QC hardware. Under the umbrella of EuroHPC, QEX will likely be the body responsible for implementing any future access policy for public EU QC resources.

These EU policy ambitions for QC invite further questions, and some of the most significant are brought together in Box 4. For this white paper, a central question is whether the aim of *The European Declaration on Quantum Technologies* to make the EU the "Quantum Valley" of the world is indeed one the EU should pursue. Given the well-known criticism of the practices of Silicon Valley companies, the goal of modelling QC development in the EU on Silicon Valley can be challenged. Does aping the profit-driven US model embody moral leadership for the EU? Or should core EU values beyond the economic be guiding EU policies?

[30] https://www.euroquic.org/
[31] https://www.euroquic.org/quics-response-to-the-call-for-evidence-on-the-eu-quantum-act/
[32] https://www.eurohpc-ju.europa.eu/qex-european-quantum-excellence-centre-drive-innovation-and-applications-2025-11-12_en
[33] https://qdnl.nl/qex
[34] https://open-science-cloud.ec.europa.eu/

**Box 4: Open questions regarding EU policy**

- The *European Economic Security Strategy* explicitly calls for greater financial and technical support for low- and middle-income countries that could play an important future role in EU global value chains. Is this emphasis on global outreach and uplift compatible with the current reciprocity-based model of EuroHPC access for third countries? Do such approaches risk further exacerbating digital and quantum divides?
- The EU is rightly addressing its shortage of quantum skills, through the Quantum Skills Academy and other initiatives. However, current efforts focus almost entirely on developing individual expertise, with little emphasis on cultivating collective know-how and establishing EU-wide collaborative networks. Is producing a greater number of individual experts enough by itself to support the EU's quantum ambitions?
- QEX aims to empower scientific users, businesses, and industry within the EU to utilise quantum computing by providing access to quantum hardware and open-source software, co-developing applications, and offering training programs as well as tailored support. However, the public goes entirely unmentioned. Is limiting access and support to already knowledgeable and well-resourced user groups an effective way to foster public trust in QC within the EU?

### *A timely entry point for EU values*

Existing EuroHPC access policy is oriented towards maximising returns on EU investment in its public HPC infrastructure, as measured via the proxy value of excellence, which is operationalised differently for scientific, industrial, and public sector users. Economic return is also a central ambition of the EU's current QC policy, reflected in the slogan of the EU as the "Quantum Valley of the world." However, in the context of contemporary geopolitical developments, new aspects of the significance of QC for the EU economy are coming to the fore: QC is recognised as a critical technology with both transformative and destructive potential, and therefore as crucial to the EU's technological sovereignty, geopolitical autonomy, and material security.

It may seem then that the question about how the EU ought to allocate access to its emerging QC resources is one about balancing the values of economic return on investment, sovereignty, autonomy, and security. While these values are indisputably important, they should not be accepted as exhaustive. Ongoing radical transformations in contemporary geopolitics, and of the EU's role on the world stage, alongside the time-limited pilot phase for QC access, present a generational opportunity for the EU to exhibit global ethical leadership in its approach to allocating access to its emerging public QC resources. Specifically, current circumstances create *a timely entry point for EU's founding values* beyond the economic and geopolitical in the way the EU allocates access to its emerging technological assets like QC. The EU's aims and values are articulated in Articles 2 and 3 of the Treaty of Lisbon[35] and in its Charter of Fundamental Rights.[36]

While the values and aims adopted for our recommendations are articulated more fully in Section 6: Taking Responsibility, it should be noted immediately that the European Union is constitutionally committed to promoting the global values of

[35] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12016ME/TXT&from=EN#d1e92-13-1
[36] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:12012P/TXT

> peace, security, the sustainable development of the Earth, solidarity and mutual respect among peoples, free and fair trade, eradication of poverty and the protection of human rights, in particular the rights of the child, as well as to the strict observance and the development of international law, including respect for the principles of the United Nations Charter.

These founding values co-exist harmoniously alongside the regional goals of scientific and technological progress and balanced economic growth and market competitiveness within the borders of the EU. Both the global and regional values of the EU jointly support a consistent vision of European prosperity that doesn't come at the cost of the rest of the world. The way the EU translates its domestic ambitions for QC into a concrete access policy therefore must be set against the backdrop of a global conversation about the potential for QC to promote such global values.

# 4. Taking Inspiration: Global perspectives on QC access

## *Addressing quantum divides*

At the forefront of the existing debate on access to QC is the issue of emerging "quantum divides" (Ten Holter et al., 2022; Gercek & Seskir, 2025). International organisations concerned with the global development of QC consistently urge stronger commitments to knowledge sharing and research cooperation beyond the EU (and its affiliates and traditional allies), recognising the cross-border impact of the problems QC has the potential to tackle. They seek to address the risk of economic and technological coercion and exploitation of any country or group, not just the EU and its members. This is to be achieved through coordinated international policy efforts with the aim of reducing global inequalities in access to QC and its benefits.

For example, the World Economic Forum (WEF) has produced a *Quantum Economy Blueprint*[37] that is explicitly motivated by the need to avoid a future quantum divide. The WEF encourages first-mover governments to provide broad global access to their national and regional public QC resources and to incentivise commercial QC providers within their jurisdiction to do the same. The WEF recommends that such broad access be complemented by globally inclusive QC education, for example, by establishing QC courses in secondary school curricula and establishing QC scholarships for members of under-represented groups. These recommendations bear directly on the EU's policy priority of developing a quantum literate workforce, widening it into a global imperative.

In their *Report on the Ethics of Quantum Computing*,[38] the UNESCO World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) identifies emerging quantum divides as a key issue for the global development of QC. Echoing the views of the WEF, the COMEST report identifies a need "to coordinate education and talent mobility across the world with a view to bridging skills disparities" (2024, p. 9) and to "expand the scientific community and increase its representativeness" (p. 24). They encourage the implementation of open access publication policies, the democratisation of QC access through the cloud, and global knowledge sharing – while "keeping in mind potential risks from publishing security-related and decryption-related research outputs" (p. 24).

The COMEST report broadens the issue of quantum divides from missed opportunities for global economic uplift to potentially destabilising geopolitical power imbalances arising from the

[37] https://www.weforum.org/publications/quantum-economy-blueprint/
[38] https://unesdoc.unesco.org/ark:/48223/pf0000395183.locale=en

consolidation of technological power in a small number of corporations and governments, and the risk of technological coercion and exploitation of less-resourced states and groups. COMEST urges that research and development of QC should embody "a spirit of collaboration and coordination with regard to legal initiatives and effective governance" (2024, p. 25) and that applications of QC "must be guided by shared values and comply with international human rights standards, the rule of law and intergenerational and intragenerational justice" (p. 26).

Addressing quantum divides therefore raises a more fundamental normative question: according to which shared values should access to quantum computing be governed?

### *QC for global values*

Several international organisations have sought to articulate the values that should underpin future global QC governance. The WEF, for example, has developed governance principles for a future quantum economy,[39] underpinned by global values. These go significantly beyond mere national and regional return on investment, and include the (global) common good, (global) inclusivity, (global) equitability, and (global) accessibility. From these, the WEF derives core aims, organised into themes such as societal transformation, open innovation, workforce development, and standardisation.

The COMEST report emphasises the continuity of the values implicated in the global development of QC technologies with those for other technologies, including those identified in UNESCO's *Recommendation on the Ethics of Artificial Intelligence*[40] which aim "to provide a universal framework" (2021, p. 21) of values and principles for the ethical global development of AI. These include respect for human rights, diversity and inclusivity, ecological flourishing, and peaceful and just societies; these are to be pursued through international cooperation to ensure fair global access to and distribution of the benefits of AI. COMEST's recommendations for QC extend these values and principles.

The COMEST report also connects these issues with those of democracy, societal trust in technology, and technological sovereignty, bringing their recommendations into even closer contact with extant EU policy priorities. As well as being engines of a fair future quantum economy, equitable access and inclusive quantum education can be tools for ensuring the societal uptake of QC as a trusted *socio*-technical system: "When only a select few truly understand the technology, power concentrates with technical experts and those who fund or employ them, undermining public oversight, informed consent and representative decision-making" (2024, p. 10). Fostering quantum literacy, *not only for the future quantum workforce but also for the public*, therefore becomes a democratic imperative on a global scale. This democratic imperative for public access is something that should be reflected in any future access policy for QC in the EU.

These global values, while important, must be meaningfully operationalised to have practical significance for any future QC access policy. Across the international debate, the UN 2030 Sustainable Development Goals (SDGs) have emerged as the principal framework for operationalising these broader global commitments.[41]

[39] https://www.weforum.org/publications/quantum-computing-governance-principles/
[40] https://unesdoc.unesco.org/ark:/48223/pf0000381137
[41] https://www.weforum.org/publications/quantum-for-society-fulfilling-the-promise-of-the-sdgs/

### *QC for the SDGs*

Significant emphasis has been placed on the potential for QC to contribute to advancing the SDGs. In their *Quantum technologies policy primer*,[42] the OECD identifies how QC-enabled optimisation and simulation can contribute to, for example: SDG 2 (Zero Hunger), through the optimisation of farming practices and the development of new fertilisers and alternatives to existing pesticides and insecticides; SDG 3 (Good Health and Wellbeing), through accelerated drug discovery, personalisation, as well as enhanced diagnostics; SDG 6 (Clean Water and Sanitation), through the optimisation of water management infrastructures, accurate water stress forecasting, and the reduction of water waste; SDG 7 (Affordable and Clean Energy), through the optimisation of energy grids, the development of more energy efficient conductive materials, and more accurate energy demand forecasting; SDG 11 (Sustainable Cities and Communities), through the optimisation of urban planning to improve air quality and reduce urban heat stress, the development of strong and more resilient construction materials, and the modelling and optimisation of urban traffic flows; and SDG 13 (Climate Action), through the optimisation of energy consumption, accelerated development of renewable energy sources, batteries, and carbon capture technologies, and more accurate climate and weather models.

The WEF calls for intelligently designed access institutions, initiatives, and incentives to promote SDG- over solely profit-oriented use and to avoid what they call a "two-speed" development of applications (2024b, p. 22) – whereby applications of particular interest to certain dominant groups are developed quicker than applications that serve the interests of a more inclusive range of stakeholders. For example, pharmaceutical companies invest heavily in QC to speed up drug discovery and drive profits, while other SDG-relevant applications of QC with looser links to industry, such as climate modelling and water stress forecasting, languish from underinvestment. The WEF points to the success of SDG-oriented challenges, hackathons, and Public-Private Partnerships (PPPs) with a clear focus on social impact as a model for future initiatives. Owing to the global nature of the SDGs and the need for global solutions, the WEF emphasises the need to promote globally inclusive international cooperation on SDG-oriented QC research. This complements the emerging European emphasis on mission-oriented collaboration on "grand challenges," but extends it beyond the ambition of European competitiveness towards globally shared goals.

Positioning QC as crucial to a future sustainable global economy, the WEF highlights the need for quantum energy advantage in addition to computational advantage – that is, for it to be possible to complete tasks on a quantum computer not only more quickly and accurately, but also less resource intensively, than on a classical supercomputer (cf. Affuèves, 2022) – for the adoption of QC technology in pursuit of the SDGs to be meaningful and worthwhile. To this end, they advocate for the establishment of a standardised energy consumption metric to enable comparison of the resource intensiveness of QC applications with that of comparable HPC applications. Likewise, COMEST urges international policy efforts to promote "energy-efficient designs, the use of recyclable materials, investment in renewable energy sources for quantum data centres and integration with clean infrastructure" (2024, p. 26) to align QC development with the SDGs. One may question whether the introduction of another resource-intensive technology such as QC can realistically contribute to a future sustainable economy at all; nevertheless, such recommendations reflect an ambition towards the sustainable development of QC.

[42] https://www.oecd.org/en/publications/a-quantum-technologies-policy-primer_fd1153c3-en.html

The Open Quantum Institute (OQI),[43] an initiative hosted by CERN under the umbrella of the Geneva Science and Diplomacy Anticipator (GESDA), approaches the use of QC for the SDGs from a complementary perspective. While the WEF primarily advocates institutional incentives for SDG-oriented innovation, OQI seeks to demonstrate how the use of quantum technologies can be actively steered towards SDG-oriented applications. Rather than assuming the SDGs will naturally be served by a well-governed future quantum economy, OQI advocates a more interventionist approach to ensuring QC applications are societally beneficial.

Concretely, OQI recommends mandatory responsible technology assessment prior to a proposed use case receiving funding and being granted access to QC resources. Furthermore, it calls for hardware developers to make its best-in-class systems available for SDG-related research at low or no cost, application developers to dedicate a proportion of their research efforts to SDG-related projects, and public and private funding agencies to reserve part of their funding for research with SDG-related objectives. Quotas – such as allocating approximately 10% of available research capacity or funding to SDG-oriented activities – are proposed as a concrete mechanism for orienting future QC development and applications towards the SDGs.

Similarly, the COMEST report advocates not merely for the incentivisation of SDG-oriented use of QC resources to avoid two-speed use-case development, but for integrating comprehensive and continuous assessment of the political, socio-economic, cultural, and environmental impacts of QC "at every stage of quantum computing – research, development, deployment, implementation and use" (2024, p. 23) to ensure that human rights principles and sustainability aspirations are upheld. This would be achieved through coordinated regional, national, and international regulation – including QC access policies – and is explicitly connected to the aim of establishing societal trust in QC.

Taken together, these recommendations suggest that international voices are calling for more than just alternative approaches to allocating access to QC. They point towards a more fundamental reconceptualisation of QC itself, one that treats QC as a resource whose governance should serve shared global interests rather than solely national or commercial ones.

### *QC as a global common*

Taken seriously, these collective global values imply a corresponding shift in how QC itself is understood as a resource. Specifically, COMEST advocates for the radical reconceptualisation of QC as a "global common," like the internet, outer space, the high sea, the seabed, etc. (2024, §99). This conceptualisation of QC underpins their recommendations for its development and application. It can also be read into the recommendations of the WEF and OQI regarding the distribution of benefits of QC access post-use.

For example, the WEF advocates for the open publication of the novel QC methods and procedures underpinning new results; the availability of open-source versions of prototype QC use cases; and the open publication of performance benchmarking data to support international standardisation efforts and validate global technological roadmaps. Similarly, OQI places considerable emphasis on international solidarity and the open development of QC. It promotes the development of open-source software, global standardisation, and international research partnerships and capacity-building initiatives that distribute the potential benefits of QC beyond established hubs of QC research and investment while reflecting the different labour needs of different states and regions.

[43] https://open-quantum-institute.cern/

Despite differences in emphasis, these recommendations converge on a remarkably consistent vision of how access to QC should be governed internationally. Namely, *access to QC should reflect the potential cross-border positive and negative impact of its development and implementation*. In this light, QC access policy can be seen as a mechanism for reducing global inequalities (along numerous distinct dimensions), promoting socially beneficial applications (particularly for the SDGs), fostering international solidarity, and embedding QC within a broader framework of global governance, supporting and supported by the international rule-based order.

Again, one can raise questions about these recommendations, and Box 5 lists some of the most significant. Yet these international voices provide an important touchstone for evaluating the extent to which future EU QC access policy reflects not only the EU's domestic strategic ambitions, but also its constitutional commitments to the wider world. The next section complements these high-level recommendations with the practical experiences of Europe's early quantum champions and adopters, whose day-to-day engagement with QC reveals the concrete challenges that future access policy must address.

**Box 5: Open questions regarding existing recommendations**

- Is access – either in person or through the cloud – enough to address existing and emerging quantum divides if hardware remains centralised in historically advantaged states?
- By framing QC as a tool for advancing the SDGs, are governments guilty of "technosolutionism" (de Jong & Shelley-Egan, 2026) – i.e., of reducing a complex societal problem into a technical challenge, thereby obscuring the urgent need to fundamentally change our practices?
- While QC has the potential to address global challenges, these challenges manifest differently as a result of geographical and cultural differences. There is therefore a need to develop *socio*-technical solutions – technical solutions tailored to the specific needs and understandings of specific cultures. Are current recommendations for globally collaborative development of QC enough?
- Does reconceiving of QC as a global common risk a "tragedy of the commons" (Hardin, 1968) in global QC development – i.e., a situation in which individually beneficial actions result in overall collective harm?
- Are quotas for societally beneficial QC use fit for purpose? If only 10% of applications are societally beneficial, what are the other 90% doing?

# 5. Taking the Lead: Europe's QC frontrunners

To better understand the practical requirements for a future EU QC access policy, OpenSuperQPlus has undertaken a consultation with current and prospective users of European QC resources from research, industry, and public sector institutes. Participants were identified through professional networks and snowball sampling; consequently, the consultation is illustrative rather than fully statistically representative. Nevertheless, it provides valuable insight into the experiences of those already attempting to build and exploit QC capability across the EU and highlights issues that are not yet fully reflected in existing policy discussions.

## *Early quantum champions and early quantum adopters*

Two distinct but complementary groups emerged from our consultation. The first consists of *early quantum champions*: researchers and professionals in an organisation – a university, company, or institution – who already work directly with quantum hardware and software to develop applications and advance scientific and technical knowledge. The second comprises *early quantum adopters*: organisations and institutions seeking to incorporate QC into their activities without necessarily developing detailed in-house expertise in the underlying technology. While these groups differ in their immediate access requirements, both constitute important sets of actors who will shape the EU's longer-term QC ecosystem.

The main difference between early quantum champions and early quantum adopters concerns which actors should directly receive ample access. Early quantum champions seek *direct interaction* with quantum hardware to develop hands-on experience and understanding of the practicalities of exploiting different qubit modalities. Early quantum adopters, by contrast, are primarily interested in accessing the *exploitable functionality* of QC without being bothered by the details of the hardware. Early quantum adopters therefore emphasised the importance of ample access for *intermediary organisations* – such as universities, national research organisations, and specialised service providers – that can develop the mid-stack middleware necessary for unlocking this exploitable functionality.

## *Expertise and pathways to access*

Our consultations revealed that the provision of European QC for early quantum adopters suffers from three important bottlenecks, which are largely reflected in existing EU QC policy objectives. The results of our consultation provide important clues for how these existing EU QC policy objectives should be pursued in practice.

First, early quantum champions are typically isolated professionals within an organisation who successfully develop their own QC knowledge and expertise, but lack the means – access to QC, time, or funds – to scale this individual knowledge into collective know-how that can diffuse and become embedded within an organisation. Consequently, valuable knowledge is vulnerable to being lost when these individual champions leave or move between organisations. Durable, long-term expansion and consolidation of Europe's QC expertise in research, industry and the public sectors, therefore require more than increasing the number of *individual* QC experts; it requires supporting the development of *quantum humanware*: collaborative teams and stable communities of practice capable of retaining and sharing expertise over time, upon which interested potential users can draw to benefit from the exploitable functionality of QC. Just as individual qubits and the entanglement between them need to be sufficiently robust to be useful in practice, so too does the EU's stock of QC experts and the networks between them need to be sufficiently durable to serve the EU's longer-term QC ambitions.

*"One of the cornerstones of IBM's success in quantum computing has been their decision to offer free, early access to cloud-based quantum processors. Even when those machines were still finding their footing, this openness helped cultivate a vibrant community – developers writing software, researchers implementing new algorithms, and authors publishing pioneering studies. In short, improved accessibility directly translates into greater interest and broader engagement. Likewise, since OSQ+ has been built, at least in part, with public funds, it ought to be made available – both to public institutions and to private entities – throughout the European Union."*

*Dr. Mikel Sanz, Basque Center for Applied Mathematics (BCAM), University of the Basque Country (UPV/EHU)*

Second, the development of quantum humanware in the EU depends on the availability of opportunities to practice. However, current QC resources are extremely scarce. How can the EU develop the expertise necessary to develop its portfolio of QC resources, if the development of expertise *depends on* the availability of those very resources? One answer is to train and experiment on quantum emulators: classical platforms for simulating QC. While individual qubits and small quantum circuits can be simulated efficiently on classical computers, the resources required to simulate general, highly entangled multi-qubit systems can grow exponentially with system size. Quantum emulation therefore cannot fully replace access to physical quantum hardware. However, quantum emulators can be a useful proof-of-concept tool for simple QC applications. Given the scarcity of available QC resources in the EU, the requirement for preliminary algorithmic proof-of-concept as part of existing EuroHPC access policy can therefore be updated to reflect the special context of QC: instead of allocating a portion of Europe's extremely limited QC capacity to preliminary validation, validation can take place via a dedicated quantum emulator access track.

Third, consultees also identified fragmented access arrangements as a significant barrier to capability development. Access to QC resources often depends upon informal professional networks rather than formal access routes, making it particularly difficult for newcomers to enter the field (and, as mentioned, for QC expertise to diffuse within communities of QC practice and become stable within research organisations, industry and public sector institutions). Participants consistently called for transparent, predictable, and centralised routes to access – a "quantum computing notice board", as one consultee put it – that advertise the available resources and their capabilities and reduce reliance on personal connections. To an extent, this bottleneck is being addressed by the recently announced Centre for Quantum Excellence (QEX), but details on how QEX will address fragmentation and the reliance on personal connections for QC access in practice remain sparse.

For early quantum adopters, similar points can be made. In their case, it is not they who want access; rather, early adopters argue for giving the intermediary organisations ample and well-defined pathways, such that these organisations are in a position to service early quantum adopters with useful knowledge and applications.

*"If we have a good quantum computer, we will find a good application for it."*

*Dr. Bruno Senjean, CNRS researcher, Institut Charles Gerhardt Montpellier, Pôle de Recherche Chimie, Université de Montpellier*

### *Cause for optimism: promising early QC use cases*

Our conversations with early quantum champions called into question widespread pessimism underlying much current QC policy discourse: that research into quantum computing remains almost entirely oriented towards developing prototype quantum computers that will be used almost exclusively by quantum researchers to further test and develop the technology. This stems from the perception that current quantum computers are nowhere near close to providing a "quantum advantage" over existing classical HPC in any domain. It is therefore generally assumed that access to early QC capacity within the EU is of interest only to the community of EU quantum researchers; external users – early quantum adopters, such as in industry and the public sector – must wait until the day that promising real-world QC use cases arrive.

Instead, our consultation provided cause for optimism. The current generation of quantum computers should not be seen as mere prototypes, technically interesting but practically useless, but already as potentially useful tools which may be capable of providing limited computational advantage over purely classical computing in the near term. A case in point are optimisation problems in electrical grids, especially in the context of the transition to renewable energy sources – such as using dynamic pricing to manage variable electrical loads arising from renewable energy sources and the formation of self-sufficient prosumer microgrids. Crucially, because energy is bought and sold at market on short timescales – approximately every fifteen minutes – there is a trade-off between the precision and the speed of calculation that is very challenging for classical algorithms. Recent research funded by the German Federal Ministry of Education and Research (Blenninger et al., 2024) indicates that hybrid QC-HPC algorithms may play an important role in efficiently solving such problems.

*"If we're trying to prove quantum advantage, let's try to do it for something that benefits humanity."*

*Dr. Corey O'Meara, Chief Quantum Scientist, E.ON*

Given such near-term potential to contribute to important and societally relevant computational challenges, early quantum champions emphasised the need to experiment freely with QC resources, and the need for ample access to QC resources to enable such experimentation. Moreover, such experimentation should be done within broad transdisciplinary collaborations, bringing together knowledge horizontally from different application domains and vertically from research and industry – further emphasising the need for stable communities of practice capable of retaining and sharing expertise over knowledge isolated within individual experts, forming the basis of the quantum humanware essential for achieving the QC ambitions of the EU.

Early quantum champions and early quantum adopters are the hidden assets of the EU. They are the ones who will give the EU the knowledge communities in QC, expand the use cases for QC, and give the EU a flying start when new generations of quantum computers make more use cases advantageous. Our consultations came with a warning: the risk for the EU of not tailoring QC access to the needs of early quantum champions and early quantum adopters is that larger companies – big tech – and larger institutes, often outside of the EU, dominate the emerging use of quantum computing, to the detriment of EU competitiveness.

*"Flood the community with qubits."*

*Prof. Jean-Philip Picquemal, director of the Theoretical Chemistry Laboratory, Sorbonne University/CNRS & Co-founder, Qubit Pharmaceuticals*

# 6. Taking Responsibility: Values and aims for EU QC access

The question of how the EU should allocate access to its emerging QC infrastructure is ultimately a question about values. As explored in Section 2, current EuroHPC access policy aims to maximise the EU's return on investment in its public HPC infrastructure; this is reflected in the adoption of "excellence" as the central evaluation criterion for proposals and its reciprocal approach to granting global access to its resources. Other policy elements, such as pre-use ethical checks and post-use reporting and publication obligations, reflect additional though subsidiary values of trustworthiness and open science. As explored in Section 3, current EU policy priorities for QC reflect a deteriorating geopolitical context in which the values of security, sovereignty, and autonomy are coming to the fore; at the same time, QC is framed as essential to the EU's continued prosperity.

Nobody can reasonably object to the inclusion of these values – efficiency, trust, openness, security, sovereignty, autonomy, and prosperity – in the conversation about how the EU should allocate access to its emerging public QC infrastructure. However, one may object to the inclusion of these values at the exclusion of all others, or to the purely regional operationalisation of these values within the borders of the EU (Shelley-Egan & Vermaas, 2024). As explored in Section 4, international voices – such as the WEF, UNESCO, the OECD, and the OQI – have called for greater emphasis on *global values* in conversations about allocating access to emerging global QC resources, and for the global operationalisation of currently dominant values beyond national and regional borders. Conversations about access should also be steered by, among others, the global values of equality, equitability, solidarity, inclusivity, diversity, accessibility, sustainability and ecological flourishing, peace, and democracy.

The EU itself is constitutionally committed to fundamental values and aims that overlap significantly with those outlined above, including those reflected in the SDGs. As stated in Article 2 of the Treaty of Lisbon:

> The Union is founded on the values of respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities. These values are common to the Member States in a society in which pluralism, non-discrimination, tolerance, justice, solidarity and equality between women and men prevail.

From these founding values the EU derives its fundamental political aims, as articulated in Article 3 of the Treaty of Lisbon. These include promoting peace, security, cohesion and solidarity among peoples, the eradication of poverty, sustainable economic development, and strict observance and development of international law. Crucially, the EU's founding charter explicitly commits itself to pursuing these aims not only within its own borders, but also *within the wider world*. It therefore follows that the conversation about how to allocate access to the EU's emerging QC capacity should, where appropriate, become *more global* as well as regional – paying due consideration to geopolitical realities, without abandoning the EU's value-driven global aspirations. This is not naivety or wishful thinking; it reflects the reasonable expectation that the EU, through its policies, consistently embodies the full spectrum of aims and values upon which it is founded. The EU's role in any future global quantum economy should be one of consistent ethical leadership.

Different founding values will carry different weight in different decisions about access to QC. This is partly because the impact of QC will be limited to specific – though nevertheless societally significant – application domains, in which specific, classically unsolvable computational problems play a significant role. However, the relative weights of these relevant values should not

be predetermined by policymakers, but arrived at through an inclusive, optimally informed, and mutually sympathetic democratic process of public consultation, with special care taken to include non-experts and those from historically marginalised demographics, including women, ethnic minorities, rural and lower income communities (Lane, 2026).

Moreover, the practical requirements faced by the EU's early quantum champions and early quantum adopters, as explored in Section 5, foreground certain values as crucial for creating a QC "community of practice" within the EU – among them diversity, inclusivity, solidarity, and openness. Taking inspiration from international voices on QC, priority should be given to the harmonious pursuit of a plurality of aims and values through a unified QC access policy, orientated towards EU values – including global values – by default and from the start. This stands in contrast to current EuroHPC access policy, which silos different values and users into parallel access tracks, with independent assessment criteria, and with only baseline ethical compliance and sustainability enforced at the administrative level.

Based on the foregoing considerations, we identify the following six values and derived aims as essential to any future EU QC access policy:

1. The public good – directing quantum computing towards broader societal benefit rather than solely commercial and strategic objectives. The public good includes important subsidiary values. Prosperity is one, and so are security, peace, trust, democracy, and sustainability.
2. Strategic autonomy – strengthening the EU's technological sovereignty and long-term capacity for self-reliance, reducing vulnerability to exploitation and coercion.
3. Responsible innovation – accelerating the sustainable development and effective and efficient use of quantum computing.
4. EU and global solidarity – fostering cooperation within the EU by reducing fragmentation, while contributing to cooperative international efforts to address global challenges, such as the SDGs.
5. Accessibility – lowering barriers to meaningful participation and broadening access to a more diverse and inclusive range of users.
6. Fairness – ensuring the transparent and equitable allocation of scarce quantum computing resources, satisfying claims to access in proportion to their strength.

The global perspective on QC access reflected in these six values should not be understood as replacing or competing with the more regional economic perspective: that access to QC resources in the EU should prioritise the industrialisation and manufacturing of QC within the EU. The public good includes prosperity and the goal of bringing QC to industry. The value of strategic autonomy demands that QC access supports the development of a thriving QC industry within the EU. And the four consecutive values are about broadening the social and economic basis of that industrialisation, strengthening the workforce and consumer base available to industry, while at the same time fostering public trust in the products industry will offer to the EU market. Rather, what is reflected by the inclusion of global values in our list is that the success of QC in the EU need not be at the expense of the rest of the world; *QC access is not a zero-sum-game*.

"We mustn't forget that we also profit from helping others for the common good."

*Anonymous OpenSuperQPlus researcher*

The six values are not intended to be exhaustive, but rather representative of the broad array of values that emerged from the discussion of this and the previous sections. Before presenting our

recommendations in Section 8, however, Section 7 develops a conceptual framework for understanding the different dimensions along which QC access policies can vary.

# 7. Taking Shape: Mapping the policy space for QC access

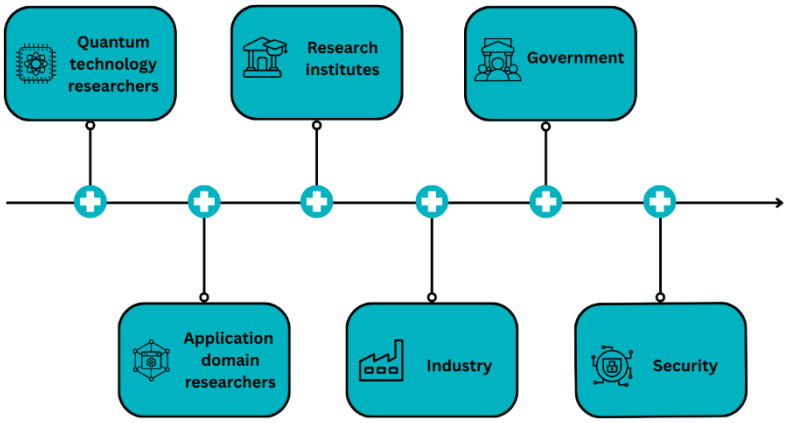
"Access to QC" can be interpreted in several different ways. Some conceptions of access focus on the users: *who* provides access and *to whom*, *what* they are permitted to do, and *why* access is provided in the first place. Others focus on the QC resources themselves: *where* those resources are located and *how* users interact with them. Together, these possibilities for thinking about access constitute what might be referred to as a "space of access". Each dimension of this space presents a question (or set of questions) that any access policy must answer – *who*, *what*, *why*, *where*, and *how* – and a range of possible approaches to answering it. Thus, any QC access policy occupies a particular region of the QC space of access.

The recommendations that follow make use of the guiding metaphor of a space of access to carve out an access policy tailored to the EU's aims and values identified above. However, the metaphor of a space of access also creates room for alternative proposals and different visions for QC access policy. It can thereby serve as a useful orienting framework for future debates on the subject – a map for navigating possibilities.

Readers interested primarily in QC governance may wish to focus on the Who, What, and Why dimensions; those concerned with QC infrastructure and implementation may find the Where and How dimensions most relevant.

## *Who-dimension: from regional specialists to global societies*

The first dimension concerns the users that receive access to quantum computing – the *who*. Access may initially be restricted to quantum technology researchers and engineers responsible for developing the technology itself. As the technology matures, access can expand to researchers in application domains, such as pharmaceuticals and engineering, followed by industrial users, public institutes, such as metrology laboratories, governments, and security organisations. Thus, which users receive priority will evolve over time. This point also emerged from a stakeholder workshop held by SURF (Lane, Mittal & Torres-Knoop, 2025, p.18) regarding access to their quantum computer procured jointly with EuroHPC. [44]




[44] https://quantumforgood.eu/allocating-access-to-quantum-computing-a-legal-ethical-framework/

*Figure 1: Spectrum of users in the QC access policy space*

Access policy must also determine the *geographical scope* of access. Quantum computing may be reserved for researchers within countries hosting quantum infrastructure, extended to all EU Member States, opened to trusted international partners, or made available more broadly to support global scientific collaboration and societal challenges. The appropriate scope depends on the balance policymakers seek between strategic autonomy, economic competitiveness, security, and international cooperation.

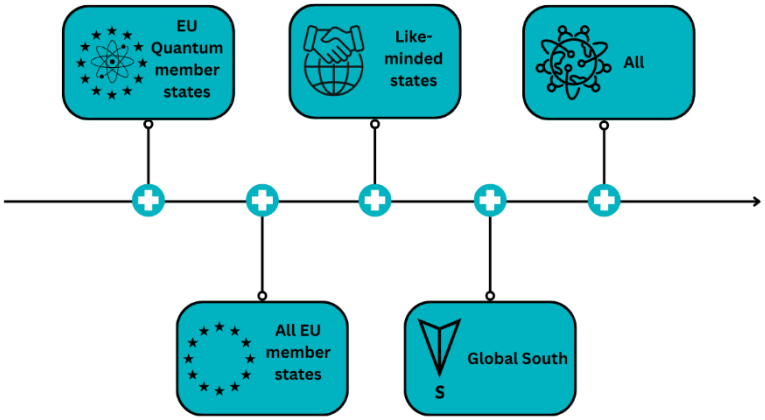



*Figure 2: Geographical spectrum in the QC access policy space*

Owing to their technical complexity, their dependence on existing technological infrastructure, and their financial cost, QC will be in reach for only a few states, institutes and companies. Moreover, QC is increasingly falling under export control and knowledge security measures, such as the Wassenaar Arrangement. While cloud computing makes global access to QC technically possible, policy choices continue to determine who is ultimately able to benefit from these resources.

A third and final sub-dimension concerns the *providers* of access and their obligations under a future QC access policy. In the case of EuroHPC, these are the Hosting Entities with whom EuroHPC has jointly procured QC hardware and with whom they share access in proportion to their financial contribution to the initial procurement. The question of how hosting entities ought to allocate their share of access to QC resources has already been discussed (Lane, Mittal & Torres-Knoop, 2025). For present purposes, what matters are the responsibilities of the Hosting Entity regarding the EuroHPC share of access. Such responsibilities will be specified in the Hosting Agreement into which the Hosting Entity enters with EuroHPC, which will be based on the generic Model Hosting Agreement.[45]

[45] https://www.eurohpc-ju.europa.eu/document/0302454a-aa5d-4686-999c-42adba1dc37c_en?filename=03-%20Annex2_%20Hosting%20Agreement%20HighEnd_.pdf

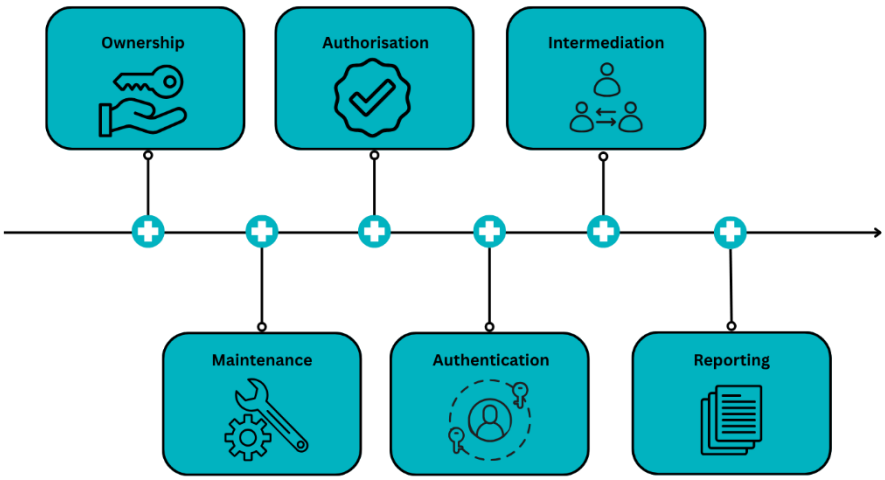



*Figure 3: dimension of provider responsibilities in the QC access policy space.*

As outlined in the current EuroHPC Model Hosting Agreement, Hosting Entities are responsible for the operation and management of EuroHPC hardware. Their obligations include ensuring the proper operation and security of EuroHPC hardware and surrounding infrastructure, applying EuroHPC's access-time conditions and rules, and informing EuroHPC of relevant information pertaining to the use and functionality of its hardware. However, EuroHPC remains the sole owner of the hardware managed by the Hosting Entity. It is an interesting and important question how the EuroHPC Model Hosting Agreement might be updated to reflect the unique attributes and context of QC.

### *What-dimension: from practicing to computing for future use cases*

The second dimension concerns the activities for which users gain access – the *what*. Access may be intended primarily for developing expertise through hands-on practice, for running applications that indicate near-term quantum advantage, or for exploring future applications that remain beyond present hardware capabilities. Different forms of access therefore support different stages of technological maturity.

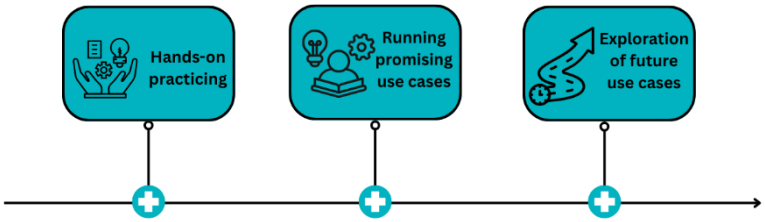



*Figure 4: Spectrum of activities in the QC access policy space*

Current quantum computers lack the scalability and stability required for advantage over classical computing in most application domains. Consequently, much present-day QC use consists of developing expertise, testing prototypes, and preparing for future use cases. Nevertheless, a growing number of hybrid QC-HPC applications already give cause for optimism about the near-term usefulness of QC in some important application domains. Access policies should reflect the need to balance exploration and experimentation with capitalising on the promise of early use cases.

### *Why-dimension: from economics to societies*

The third dimension concerns the aims and ambitions based on which users and activities are granted access – the *why*. QC has been embraced for various goals, starting with creating new economic activity and breaking digital encryption but evolving to scientific discovery, national sovereignty, defence and addressing societal challenges through, e.g., supporting the realisation of the United Nations' Sustainable Development Goals. The aims reflected in QC access policy will determine which users receive access, which applications are prioritised, and how success is evaluated.

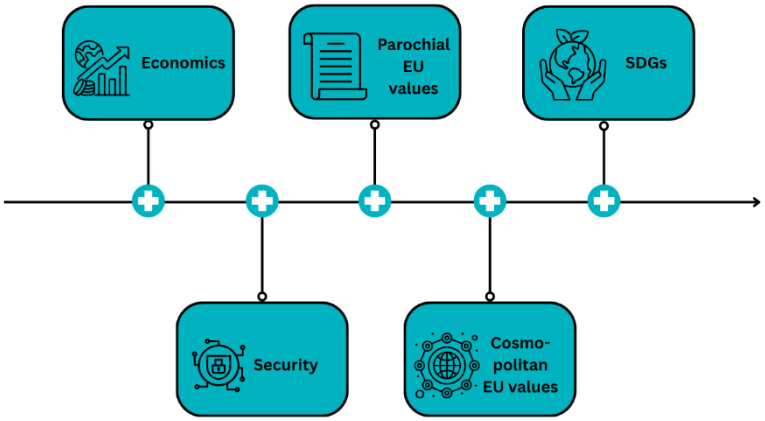



*Figure 5: Spectrum of aims in QC access policy space*

### *Where-dimension: from test trials on lab prototypes to cloud computing on national infrastructure*

The fourth dimension concerns the relative location of quantum hardware and its users – the *where*. Access may involve experimental prototypes accessed within research laboratories, commercially deployed standalone in-house quantum computers, quantum processors integrated into HPC facilities, or national quantum computing centres providing remote access as part of public digital infrastructure.

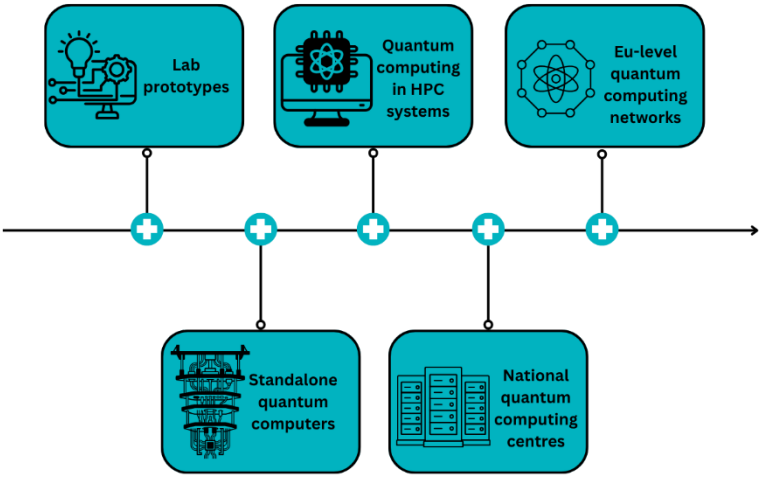



*Figure 6: Spectrum of relative location of hardware and users in the QC access policy space*

As with the previous dimensions, these different locations correspond to different stages in the maturation of QC technologies. As quantum computers move from laboratory prototypes to shared research facilities and ultimately to national and regional infrastructure, access becomes less a matter of participating in experimental research and more a matter of providing a reliable computing service. Access policies must be sufficiently flexible and adaptable to accommodate these changes.

### *How-dimension: from coding to service*

The final dimension concerns the way users interact with quantum computing resources – the *how*. At one end of the spectrum, users work directly with quantum hardware. Increasingly, however, access may be mediated through middleware, domain-specific QC software libraries, and third-party service providers.

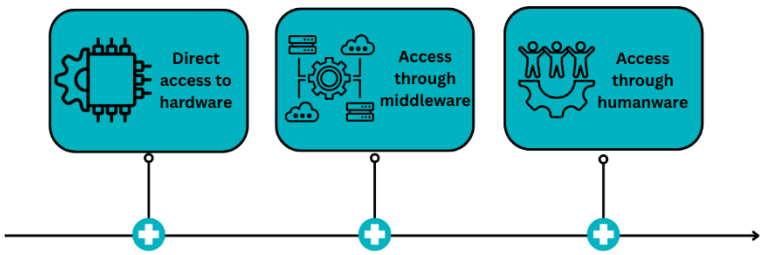



*Figure 7: Spectrum of interactions with hardware in the QC access policy space*

Like the preceding dimensions, this spectrum partly reflects an aspect of the temporal evolution of QC technology and mirrors the historical development of classical computing, where progressively higher levels of abstraction eventually made computing accessible to broad communities of users. As QC technology matures, the way users access it is therefore likely to shift from requiring specialist programming expertise towards service-oriented models that prioritise usability, interoperability, and accessibility.

These dimensions of QC access, like the qubits they govern, are often entangled. Decisions about who receives access depend in part on how access is provided; the purposes for which access is granted influence what activities are prioritised; and the location of quantum computing infrastructure shapes who can realistically benefit from it. Individual access policies therefore occupy regions within the space of access rather than single points along isolated dimensions.

## 8. Value-Led Recommendations for EU Access to QC

Having identified our core values and mapped the policy space of QC access, we now carve out a position within that space, offering value-led recommendations for the future of EU access to QC. Three overarching themes cut across our recommendations:

1. Building strong quantum computing communities of practice within the EU. This serves the values of responsible innovation and EU strategic autonomy.
2. Reducing barriers to meaningful access to quantum computing within the EU. As well as fostering communities of practice within the EU, this serves the values of accessibility and fairness.

3. Embedding EU founding values into the governance of quantum computing. This serves the values of the public good and European and global solidarity.

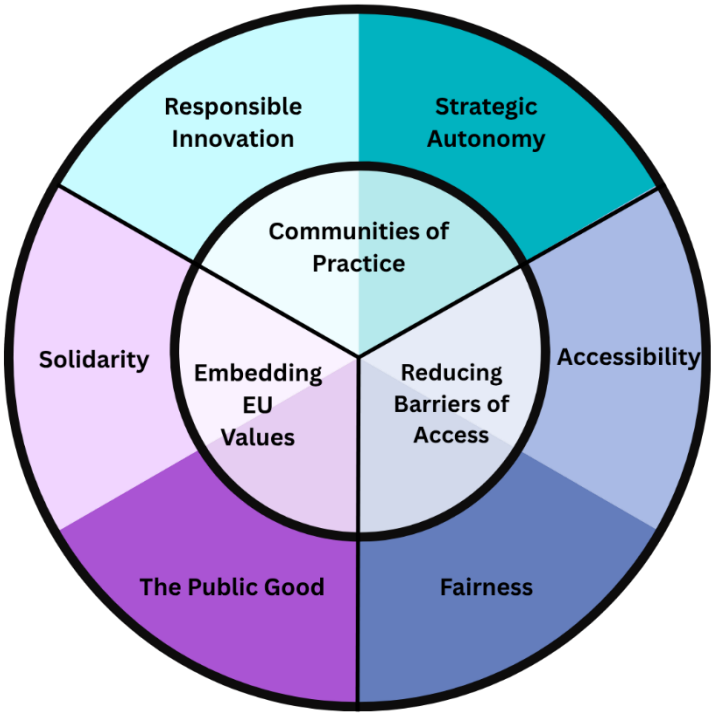



*Figure 8: Relationship between overarching themes and core values in the recommendations for future EU QC access*

## Who-dimension recommendations

### 1.1. Facilitate access to quantum computing to all in the EU

The EU should facilitate centralised, cross-border access to quantum computing for scientific, industrial, and societal actors across all sectors. This is needed because nationally fragmented access limits collaboration between Member States and makes it harder for quantum firms within the EU to scale internationally, while the current EuroHPC practice of siloing scientific, industrial, and societal into separate access tracks can reinforce isolation between sectors. The EU should therefore establish transparent, EU-wide access pathways based on shared EU values, building on Recommendations 3.1 and 4.2, and designed to enable collaboration across Member States and sectors. This would strengthen **trust** and **solidarity** and ensure that the EU's emerging quantum computing infrastructure contributes to **the public good**.

### 1.2. Create public access to quantum computing

Access to quantum computing in the EU should be widened to include the public, from schoolchildren to curious citizens. This is needed to ensure that quantum computing infrastructure is treated (and perceived) as a **public good**. The extent and mode of public access should reflect the maturity and operational availability of the underlying hardware. Emulator-based access and educational interfaces can complement limited access to physical quantum computers, particularly during the early stages of technology development. This would provide entry points for beginners, a sandbox for unconventional use cases, and a basis for forming inclusive and representative communities of practice. The provision of public access must be balanced against the opportunity cost of granting access to inexperienced users, the risk of access by malicious actors, and conformity with export controls. Nevertheless, broader access would advance **fairness** and **accessibility**, while helping to generate unexpected applications and strengthen **solidarity** and **trust** among users and the European public.

### 1.3. Give commercially and socially strategic global access to quantum computing

The EU should introduce targeted non-reciprocal policies for global access within well-defined limits, developed in close consultation with European industry, to complement its existing reciprocity-based policies. The intensifying geopolitical competition in quantum computing is pushing the EU towards protectionist measures, despite the EU's desire to maintain extensive economic and political relationships with states beyond the EU and its aspiration to contribute to sustainable global development. The EU should acknowledge that under certain circumstances, global access can contribute to realisation of the EU's aims and values even when not premised on like-for-like reciprocity. Collaboration with partners outside the EU will broaden the QC market for EU industry. Exchange programmes for students and researchers from across the world to train on and use EU quantum computers provides much-needed person-power for the EU while mitigating global quantum divides. The EU should provide clear guidance to private quantum computing providers on international collaboration. This would add depth and nuance to the ambition of the EU to become the Quantum Valley of the world, support the UN Sustainable Development Goals, and promote **global solidarity**.

## What-dimension recommendations

### 2.1. Cultivate quantum computing communities of practice

The EU should actively build resilient quantum computing communities of practice for research, industry, and the public sector. This is needed because reliance on individual quantum champions risks losses of expertise when they move between institutions or regions and limits the diffusion of knowledge across the EU. Access policies should therefore foster greater transdisciplinarity, cultivate institutional as well as individual knowledge, and establish quantum computing mentoring schemes. Stronger communities of practice would improve **fairness** and **accessibility** by widening access to knowledge and skills, while providing the collective "humanware" needed to support a growing user community would advance the values of **responsible innovation** and **strategic autonomy**. While priority should be given to developing communities of practice residing and working within the EU, the establishment of global communities of practice can also serve the EU's strategic aims and values under many circumstances.

### 2.2. Offer access combining multiple quantum computing facilities

Access to multiple quantum computing facilities should be provided to prospective EU users by providers within the EU. This is needed because quantum computing is available in different platforms, defined by the technologies used for realising qubits, and in different computational configurations, ranging from pure quantum computing to quantum computing modules integrated in high-performance computing facilities and AI data centres. For developing a nimble quantum computing community of practice within the EU, access options should include mixed-facility access packages, combining access to different providers of different qubit platforms in different computational configurations through centrally coordinated schemes. This would enable researchers to assess the strengths and limitations of different facilities and switch between them more easily, supporting **responsible innovation** and **strategic autonomy** while accelerating the development of interoperable quantum software proposed in Recommendation 5.1.

### 2.3. Prioritise application of promising early use cases

EU access policy should prioritise promising early use cases, with evidence of potential for near-term quantum advantage and – crucially – the creation of related IP. Such potential should be assessed through appropriate benchmarking against competitive classical methods, taking into account the capabilities and limitations of available quantum hardware. Demonstrated practical quantum advantage should not be a prerequisite for supporting promising exploratory use cases. Reasonable prioritisation of promising early use cases can encourage the uptake of quantum computing in industry, the establishment of intellectual property in the EU, and the build-up of communities of practice to unlock the exploitable functionality of quantum computing for industry, promoting the values of **responsible innovation** and **strategic autonomy**. The sharing of early use cases through dedicated centres for knowledge dissemination, as proposed in Recommendation 3.2, will speed the uptake of early quantum computing use cases even further, while promoting **accessibility**.

## Why-dimension recommendations

### 3.1. Prioritise the realisation of EU's values with quantum computing

The EU should explicitly adopt its founding values as criteria for determining priorities for investment in and allocation of EU quantum computing resources. Current EU policy discourse frequently frames quantum computing as an engine of economic growth and competitive advantage, prioritising the development of commercial use cases. This places economic values ahead of other values. While economic prosperity is an important objective, quantum computing also has the potential to serve non-economic and non-strategic values, including **peace**, **trust**, **democracy**, and **sustainability**. Adopting such values as criteria for determining access would ensure that quantum computing in the EU develops in accordance with the EU's wider societal ambitions. Public inclusion, mitigation of misuse, and transparent decision-making about accessed, as emphasised in Recommendations 1.2, 3.3, and 4.2, would further promote public **trust** in quantum computing as a technology that will be used in service of **the public good**.

### 3.2. Establish knowledge centres for early use cases of quantum computing

The EU should establish transdisciplinary knowledge centres to collect and disseminate quantum computing applications and use cases to future users. This is needed because quantum computing knowledge is currently concentrated among early adopters, while existing initiatives primarily support those already engaged with the technology, limiting its diffusion to new users and sectors. Knowledge centres should systematically collect the knowledge and use cases generated by early adopters, make them readily accessible through open repositories and other resources, and stimulate the establishment of intellectual property by EU-based industry. Where possible, these functions should build on existing or planned European and national initiatives, such as the Centre for Quantum Excellence (QEX), avoiding unnecessary duplication of institutional structures. This would accelerate the diffusion of quantum computing knowledge and its potential applications, supporting **responsible innovation** and **strategic autonomy**.

### 3.3. Foster accountability and mitigate misuse of quantum computing

The EU should swiftly develop regulations for misuse of quantum computing. This is needed to anticipate regulatory gaps before a mature market for quantum computing services emerges, establish institutional incentives for the responsible provision of quantum computing services, create trust within industry to invest in QC, and educate the public about the potential for misuse at an early stage. At the other extreme, the EU should take seriously the option of placing moratoria on lines of research with known risks, such as RSA-breaking quantum decryption, until sufficient mitigation is in place. Any consideration of such restrictions should be proportionate to the demonstrated risks and should distinguish potentially harmful deployment from legitimate research intended to assess vulnerabilities and develop appropriate safeguards. This should be done in close consultation with industry, without compromising on **responsibility** and **transparency**. Together with Recommendation 3.1, these measures can help steer the development and use of quantum computing towards applications that serve **the public good** and foster **trust** and **solidarity** between users and the public.

## Where-dimension recommendations

### 4.1. Enable upgrading of quantum computing hardware

The manufacture and procurement of quantum computers in the EU should support upgrade pathways, modular replacement of components, and leasing arrangements that enable early buyers to transition to new generations of hardware. This is needed because procurement may be a pathway to more shielded access for industry, defence, and security, freeing up more inclusive access to publicly managed resources. The rapid pace of quantum computing development creates a risk that early adopters will be left with quickly obsolete systems, discouraging investing in first-generation hardware or creating an unsustainable cycle of hardware replacement. Manufacturers and procurers should therefore develop upgrade packages and other mechanisms that allow existing systems to incorporate new generations of components or be replaced without requiring complete reinvestment. This would reduce the risks associated with early adoption, supporting **strategic autonomy**, while avoiding a "quantum iPhone" pattern of rapid obsolescence, thereby supporting **responsible innovation** and **sustainability**.

### 4.2. Transparent access rules for quantum computing

Information about available quantum computing resources, eligibility requirements, application procedures, and selection criteria should be easy to find and communicated in language that non-specialists can understand. This is needed because opaque access processes create barriers to entry, enable informal gatekeeping, and risk excluding potential users from scarce quantum computing resources. Providers within the EU should therefore make access information and selection criteria publicly available, clearly explained, and easy to navigate. Where feasible, such information could also include the technical capabilities and expected availability of the quantum computing resources, recognising that these may evolve as systems are developed and upgraded. Transparent processes would strengthen confidence that quantum computing resources are allocated fairly among research, industry and public sector stakeholder, and for beneficial purposes, advancing **accessibility** and public **trust** in quantum computing as a technology serving **the public good**, in combination with Recommendations 1.1, 1.2, 3.1, and 3.3.

### 4.3. Facilitate secure and equitable remote access to quantum computing

The EU should develop infrastructure that enables secure and equitable remote access to quantum computing resources across all Member States and regions. This is needed because uneven local access arrangements can undermine **solidarity** within the EU. In the near term, secure remote access can be provided through existing classical communication networks, supported by appropriate authentication, authorisation and data-protection mechanisms. Future developments in quantum communication networks may enable additional capabilities, but are not a prerequisite for remote quantum computing access. Moreover, secure and equitable remote access would support the kind of commercially and socially strategic global access envisaged in Recommendation 1.3, while strengthening **solidarity** across the EU and public **trust** in the security of quantum computing within the EU.

## How-dimension recommendations

### 5.1. Support interoperable software for quantum computing

Access to quantum computing should prioritise and support the development of interoperable programming tools that allow applications to run across different quantum architectures wherever possible. This is needed because the diversity of quantum hardware platforms risks fragmenting software development, increasing adoption costs, and creating technical barriers that hinder **responsible innovation** and limit EU's **strategic autonomy**. The development of interoperable tools allowing users to move between different hardware architectures would reduce duplication of effort, make quantum programming more **accessible** to users without deep hardware expertise, and allow developers to focus on applications rather than individual platforms, supporting Recommendations 1.2 and 2.1. Together with Recommendation 2.2, interoperable tools would enable European users to make agile use of the full range of EU's quantum computing resources and switch between modalities as required.

### 5.2. Introduce a dedicated emulator access track for training and validation

Until quantum computing is abundant, the EU should introduce a dedicated emulator access track, adapting existing benchmark and development access tracks defined within EuroHPC access policies. Users should be provided with opportunities to develop and test applications on emulators before accessing quantum hardware. This is needed to support introductory training, early use-case development, and preliminary proof-of-concept validation without diverting scarce quantum computing resources from more experienced users and mature applications. For applications where hardware-specific behaviour is important, emulator-based validation should be complemented by appropriately scoped experiments on physical quantum processors. This would improve the efficient allocation of quantum computing resources within the EU while lowering barriers to entry, expanding opportunities for learning and innovation, and supporting Recommendations 1.2, 2.1, and 3.1. In doing so, emulator access would promote **accessibility**, **responsible innovation**, and **strategic autonomy**.

### 5.3. Develop a "service stack" for quantum computing access

Users of quantum computing should be offered layered access opportunities tailored to specific user needs, ranging from direct access to qubits, through middleware providing access to exploitable computational functionality, to provider-mediated services. Such a "service stack" can be provided by multiple providers through a centrally coordinated access scheme. This is needed because hands-on access does not translate into meaningful access for most early quantum adopters, creating a significant barrier to the uptake of quantum computing in the EU. Offering different levels of support, from training and technical assistance to managed execution of quantum algorithms, according to the specific needs of different types of users, would broaden access to users with different levels of expertise and interests, stimulate industrial uptake, and make quantum computing in the EU more **accessible** while supporting **responsible innovation** and **strategic autonomy**, in line with Recommendations 1.2, 2.1, and 3.1.

# 9. Visions for future EuroHPC access regulation

### *Thinking ahead*

Classical high-performance computing has had a decades-long period for developing and finding its way to its users. During this period, the market and the users were able to codevelop, leading to a gradual matching of supply and demand, and allowing access policies to evolve for addressing governance issues in that market. For quantum computing, we want to speed up this process, requiring that the provision of quantum computers and the expertise and expectations of users are calibrated in one shot. We think it is therefore prescient that the EuroHPC JU did not apply its existing regulation for classical HPC to quantum computing and instead defined a pilot phase in which it can explore what regulation fits quantum computing. As part of the OpenSuperQPlus project, we submit our analysis and recommendations in the same spirit of exploration, aiming to shape the form and substance to a future access regulation by which the EU can make optimal use of its quantum computing potential.

Our analysis provides a set of recommendations and a conceptual framework for future thinking about QC access. As quantum computing matures and new policy challenges emerge, we hope the "policy space of QC access" can provide a common vocabulary for comparing alternative visions of how the EU – and others – should govern access to this transformative technology.

### *Operationalising value-led access policy*

The practical implementation of value-led quantum computing access policy will need to reflect the evolving maturity and operational characteristics of quantum computing platforms. In particular, early-generation quantum computers may require substantial hardware time for calibration, characterisation, maintenance, benchmarking, and further system development. The availability of computing resources for external users may therefore vary between platforms and over time. As experience with EU quantum computing access grows, future policy development could explore adaptive resource allocation approaches that balance hardware development, scientific experimentation, application development, and wider public access.

A further area for future work concerns the division of responsibilities between EuroHPC, hosting entities, and intermediary service providers for technical feasibility assessment, scheduling, security, user support, and reporting. Differentiated access pathways, ranging from classical simulation and emulation to limited and extended access to physical quantum processors, could support the efficient use of scarce resources while accommodating experiments that specifically require physical hardware. These operational arrangements could be progressively refined through experience gained during pilot access programmes and further consultation with quantum computing operators and users.

### *Shaping a positive future for quantum computing in the EU*

The recommendations presented here are necessarily provisional, reflecting the current state of quantum computing and the unique challenges facing the EU today. As the technology, its use cases, and the geopolitical context surrounding it evolve, so too should the policies governing access to it. That being said, decisions taken during this formative period will influence the global impact of quantum computing for decades to come. The EU has a unique opportunity to shape not only the future development of quantum computing, but also the values according to which access to it is governed. Now is therefore the time for the EU to exhibit strong, visionary, and consistent leadership through a value-led approach to allocating access to quantum computing.

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# Colophon

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| Antti Kemppinen | Senior Scientist | VTT | Finland |
| Stefan Knecht | Quantum Chemistry Team Lead | Algorithmiq | Italy |
| Krzysztof Kurowski | Deputy Plenipotentiary of the Director of the ICHB PAN | Poznan Supercomputing and Networking Centre | Poland |
| Sabine Mehr | Chief Quantum Projects Officer | GENCI | France |
| Carl Mensch | HPC Business Developer & Consultant | Flemish Supercomputer Center | Belgium |
| Corey O'Meara | Chief Quantum Scientist | E.ON | Germany |
| Jean-Philip Piquemal | Director of the Theoretical Chemistry Laboratory; Co-founder, Qubit Pharmaceuticals | Sorbonne University/CNRS | France |

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| Sauro Succi | Senior Researcher; Principal Investigator Multiscale and Quantum Simulations | Instituto Italiano Technologia | Italy |
| Bruno Senjean | CNRS Research Fellow | Charles Gerhardt Institute Montpellier, Department of Theoretical Physical Chemistry and Modelling | France |
| Martin Schulz | Full Professor and Chair for Computer Architecture and Parallel Systems; Member of the Board of Directors, Leibniz Supercomputing Centre | Technische Universität München (TUM) | Germany |
| Gabriele Spada | Quantum Computing and HPC Specialist | Cineca | Italy |
| Ariana Torres Knoop | Lead Quantum Computing | SURF | Netherlands |
| Jelte Zwetsloot | Research Portfolio Consultant | Alliander | Netherlands |

***Consulted organisations***

| **Organisation:** | **Region:** |
|---|---|
| Europol Innovation Lab | Netherlands |
| European Cybercrime Centre | Netherlands |
| QuIC Ethics and Societal Impact Working Group | Germany |
| European Commission | EU |