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PART 2/2

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Regulation of the European Parliament and of the Council

on a framework of measures for strengthening the Union's quantum ecosystem (Quantum Act)

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GLOSSARY

1. INSTITUTIONAL, PROGRAMME AND ANALYTICAL TERMS

Term or acronym	Meaning or definition
BR	Better Regulation: the European Commission Better Regulation Guidelines and Toolbox.
CfE	Call for Evidence.
IA	Impact Assessment.
SWD	Staff Working Document.
RSB	Regulatory Scrutiny Board.
ISG	Inter-Service Group coordinating preparation of the Impact Assessment across Commission services; sometimes referred to as the Inter-Service Coordination Group.
EC / Commission	European Commission.
EU / Union	European Union.
MS	Member State(s).
SME	Micro, small or medium-sized enterprise, as defined in Commission Recommendation 2003/361/EC.
R&I	Research and innovation.
RTO	Research and technology organisation.
JU	Joint Undertaking: a Union body implementing programmes or initiatives with Member States and, where applicable, industry or other partners.
EuroHPC JU	European High-Performance Computing Joint Undertaking. Its amended mandate covers the Union quantum-technology agenda across quantum computing and simulation, communication, sensing and metrology, in addition to high-performance computing.
Chips JU	Chips Joint Undertaking, responsible for implementing relevant semiconductor research, innovation, design and pilot-line activities, including quantum-chip capabilities.
Horizon Europe	Union Framework Programme for Research and Innovation for 2021–2027.
Digital Europe Programme / DEP	Union programme supporting the deployment of strategic digital capacities, advanced digital skills and access to digital technologies.
CEF	Connecting Europe Facility.
EIC	European Innovation Council.
EIB / EIF	European Investment Bank / European Investment Fund.

InvestEU	Union investment-support programme providing guarantees and financial instruments through implementing partners.
STEP	Strategic Technologies for Europe Platform.
ECF	Proposed European Competitiveness Fund for the post-2027 Multiannual Financial Framework. References in the Impact Assessment are subject to the outcome of the legislative and budgetary process.
ENISA	European Union Agency for Cybersecurity.
NIS2	Directive (EU) 2022/2555 on measures for a high common level of cybersecurity across the Union.
CRA	Cyber Resilience Act: Regulation (EU) 2024/2847 on horizontal cybersecurity requirements for products with digital elements.
CEN / CENELEC / ETSI	Recognised European standardisation organisations: European Committee for Standardization, European Committee for Electrotechnical Standardization and European Telecommunications Standards Institute.
SCM	Standard Cost Model: methodology used to estimate administrative and adjustment costs arising from information and procedural requirements.
CBA	Cost-benefit analysis.
NPV	Net present value: the present value of future costs or benefits after discounting.
MCDA	Multi-criteria decision analysis. A decision-support technique combining several qualitative or quantitative criteria; it is not used as a mechanical decision rule in this Impact Assessment.
OIOO	One-In, One-Out approach for examining administrative burdens and burden offsets.
Restricted Evidence Pack	Non-public supporting file containing commercially confidential, company-level, supplier-level or security-sensitive evidence. Public documents present the relevant findings in aggregated form.
Implementation modality	Institutional or operational arrangement used to deliver the selected policy package. It is analytically separate from the choice of substantive policy option.
Shared-services / split-governance model	Possible implementation arrangement in which corporate services are shared, while governance and Member State representation follow separate policy tracks. It is a delivery variant, not a separate substantive policy option.

2. QUANTUM-TECHNOLOGY TERMS

Term or acronym	Meaning or definition

Quantum technologies / QT / QTs	Technologies exploiting quantum-mechanical phenomena to provide capabilities unavailable to, or significantly complementing, conventional technologies. The principal domains are quantum computing and simulation, quantum communication, and quantum sensing and metrology.
Quantum computing and simulation / QC	Use of quantum systems to perform computations or simulations. Potential advantages are expected for particular classes of problems rather than for all computational tasks.
Quantum communication / QComm	Technologies enabling the transmission, distribution or networking of quantum information, including quantum key distribution and longer-term quantum-network capabilities.
Quantum sensing and metrology / QS	Quantum-based measurement technologies capable of improved sensitivity or precision, including applications in timing, gravity, inertial navigation and electromagnetic-field measurement.
Qubit	Basic unit of quantum information.
QPU	Quantum processing unit: hardware that executes quantum operations or circuits on qubits.
NISQ	Noisy Intermediate-Scale Quantum: current or near-term quantum systems with limited scale and significant noise, normally without full fault tolerance.
QEC	Quantum error correction: methods for detecting and correcting errors in quantum information.
FTQC	Fault-tolerant quantum computing: quantum computing using error correction and fault-tolerant architectures to perform reliable large-scale computation.
Quantum advantage	Demonstrated capability or performance advantage of a quantum approach over the best relevant classical alternative for a defined task, taking account of factors such as speed, accuracy, energy or cost.
QKD	Quantum key distribution: use of quantum principles to establish or distribute cryptographic keys with the ability to detect certain forms of interception under defined assumptions.
PQC	Post-quantum cryptography: classical cryptographic algorithms designed to remain secure against attacks using sufficiently capable quantum computers.
Quantum-safe preparedness	Organisational and technical preparation for cryptographic risks created by future quantum capabilities, including awareness, inventories, crypto-agility, testing, preparedness assessments and exercises, technical advice and implementation monitoring under existing cybersecurity frameworks.
Crypto-agility	Capacity of an organisation or system to identify, replace and manage cryptographic algorithms, protocols and keys without disproportionate disruption.

EuroQCI	European Quantum Communication Infrastructure initiative, supporting the deployment and interconnection of terrestrial and space-based quantum-secure communication infrastructure in Europe.
IRIS²	Union Secure Connectivity Programme, relevant inter alia to the space-based dimension of secure connectivity and EuroQCI.
Quantum Internet	Long-term vision of advanced quantum networks enabling capabilities beyond point-to-point QKD, potentially including distributed quantum computing, networked sensing and quantum-information services.
QIA	Quantum Internet Alliance: research and stakeholder initiative supporting development of the European quantum-internet ecosystem. It is distinct from the proposed European Quantum Alliance under the Quantum Act.
TRL	Technology Readiness Level: scale used to describe the maturity of a technology from basic research to demonstration in an operational environment.
Lab-to-fab	Progression from research or laboratory prototypes towards engineering, fabrication, integration, validation, qualification and industrial deployment.
Dual-use potential	Potential for a technology to have both civilian and security or defence applications. It does not imply that the technology is necessarily a listed dual-use item under Regulation (EU) 2021/821.
NIST	United States National Institute of Standards and Technology. It publishes technical standards and guidance, including standards relevant to PQC.
FIPS 203 / 204 / 205	NIST Federal Information Processing Standards specifying selected post-quantum cryptographic algorithms. They may be used as technical references, without displacing applicable Union or European standardisation processes.

3. POLICY OPTIONS

Term or acronym	**Meaning or definition**
Dynamic baseline (BAU)	Counterfactual scenario in which no Quantum Act is adopted, while existing and already planned Union and Member State strategies, programmes, legislation, infrastructures and market developments continue to evolve.
Policy options / PO1–PO3	PO1, PO2 and PO3 are mutually exclusive appraisal packages. They share certain building blocks, and PO3 retains the PO2 variant where no credible and proportionate stronger design was identified. PO2 is not mechanically PO1 plus additional measures, and PO3 is not mechanically PO2 plus further measures.
PO1 - Horizontal framework conditions	Option relying principally on voluntary cooperation, recommendations, guidance, mapping, common tools, technical assistance and improved use of existing instruments. It does not introduce mandatory requirements under the initiative.

PO2 - Enabling Quantum Framework Act	Targeted legislative and delivery framework establishing structured EU–Member State governance, research-to-deployment arrangements, Strategic Projects, finance and first-buyer pathways and targeted resilience measures. PO2 is the preferred option.
PO3 - **High-intensity intervention**	PO3 retains the PO2 architecture and applies higher-intensity variants only to PM7 (strategic procurement conditions), PM10 (dedicated mandate or risk-bearing financial capacity), PM11 (wider targeted mandatory dependency information requirements) and PM13 (binding PQC-preparedness duties for defined critical public authorities and operators). All other Policy Measure families use the PO2 variant
Cumulative options	PO1 adds voluntary enabling and framework-condition measures to the dynamic baseline. PO2 retains those measures and adds targeted legislative and delivery mechanisms. PO3 retains the PO2 architecture and adds, or substitutes selected higher-intensity variants. The three options remain mutually exclusive alternatives for appraisal.
Conditionality through existing vehicles	Use of work programmes, calls, grant agreements, procurement conditions or financial-instrument rules to apply common delivery requirements to supported activities, without establishing a separate general enforcement regime.

4. POLICY MEASURES AND DELIVERY STRUCTURES

Term or acronym	Meaning or definition
Policy measure / PM	Building block used to construct the policy options. The final architecture comprises PM1–PM16. The complete measure names, option variants, addressees, implementation responsibilities and cost assumptions are presented in Annex 4. Simplification by design is a cross-cutting principle applied to every measure and is not a separate costed policy measure.
Quantum Strategy Board	Proposed high-level Commission–Member State body providing strategic direction, common priority review and implementation coordination. It would not replace the operational functions of existing programme or Joint Undertaking bodies.
European Quantum Alliance	Light stakeholder interface bringing together industry, research, RTOs, users, investors and relevant standards communities. It provides input but does not exercise formal funding, certification or enforcement functions.
Common Quantum Europe R&I Programme	Coordinated European programming logic linking Union priorities with national quantum chapters or equivalent structured national inputs. It does not transfer national budgetary authority to the Union.
National quantum chapter	Structured presentation of a Member State's relevant priorities, programmes, infrastructures and planned contributions for the purposes of European coordination and review.

European Quantum Science and Technology Excellence Network	Distributed network of leading European quantum research capabilities supporting shared scientific priorities, researcher cooperation and Grand Challenges.
Quantum Grand Challenge	Mission-driven, competitively selected research or technology challenge with defined objectives, milestones, benchmarks and review points.
Quantum Entry Point / user-support Centre	User-facing first access point helping firms, public authorities and other users identify potential quantum applications and obtain access to expertise, infrastructures, finance, training or suppliers. "Think Quantum Competence Centre" may be used as the public-facing name.
Technology and Innovation Hub	Specialised European-level capability supporting quantum firms through engineering, prototyping, integration, testing, validation and qualification in a defined technology area.
Three-layer delivery model	Functional architecture connecting: (1) scientific excellence; (2) technology maturation and ecosystem growth; and (3) user access, adoption and diffusion. The layers do not necessarily require separate legal entities.
Pilot Quantum Infrastructures	Infrastructure identified on the basis of Union added value, cross-border relevance, technological maturity and deployment needs, supporting the testing, demonstration or early deployment of advanced quantum technologies. Identification does not automatically confer funding or determine procurement or access arrangements, which remain under the relevant programmes and competent bodies.
Strategic Quantum Project of European Relevance / Strategic Project	Project designated on the basis of transparent criteria, European added value and measurable milestones. Designation does not automatically confer funding, State-aid approval, procurement preference or regulatory exemption.
Quantum Investment Service Desk	Coordinated scale-up finance and strategic-capability support operating through relevant existing or future Union and national financial instruments. Under PO1, it provides finance-readiness and referral support. Under PO2, it combines a structured investment pipeline, investment-readiness support, access to appropriate financial products and private co-investment. In justified cases, it may facilitate European co-investment or coordinated counteroffers where loss of control could materially affect a strategically important quantum capability. Under PO3, it operates through a dedicated mandate or capacity within existing or future instruments' envelope with stronger risk-bearing capacity. Investment, valuation and risk decisions remain with the competent financial institutions.
Quantum Business Platform	Voluntary digital platform supporting matchmaking among firms, users and investors and, subject to safeguards, aggregated ecosystem intelligence. Participation should not automatically create regulatory obligations.

Minimum access conditions / Access Charter	Common service and access principles for supported facilities, including transparent service catalogues, application processes, access rules and proportionate reporting of utilisation and outcomes.
Stage-gate model	Milestone-based progression in which continuation or additional support depends on meeting predefined technical, operational or deployment criteria.
Lead market	Market in which coordinated public or private demand supports early adoption, reference customers and progression towards repeat deployment.
Reference deployment	Operational or near-operational deployment intended to demonstrate performance, provide a customer reference and support later adoption or procurement.
Regulatory sandbox	Controlled framework for testing an innovative application with the involvement of the competent sectoral authority. It does not suspend applicable law unless an existing legal framework expressly allows a derogation.
PCP / PPI	Pre-Commercial Procurement / Public Procurement of Innovative Solutions: procurement approaches used to support development, testing and early deployment of innovative products or services.
Monitoring and early warning	Structured collection and analysis of indicators to identify delivery bottlenecks, dependency exposure or supply risks and support proportionate follow-up or mitigation.
Trusted deployment	Deployment using appropriate performance, interoperability, security and assurance safeguards, particularly in sensitive, critical or operational contexts.
Critical components / dependencies	Components, sub-components, equipment, materials, software or services for which limited suppliers, concentration, lack of substitution or other chokepoints may create strategic vulnerability.
Targeted information request	Proportionate request addressed to clearly defined actors for information necessary for a specified monitoring or resilience purpose and unavailable from existing sources.
Trusted partnership	International cooperation based on strategic value, reciprocity where relevant, protection of Union interests, research-security safeguards and resilient supply relationships.
Once-only principle	Principle under which information already submitted to a competent public authority or programme should be reused, where lawful and technically possible, rather than requested again.

ANNEX 1: PROCEDURAL INFORMATION

5. LEAD DG, DECIDE PLANNING/CWP REFERENCES

The lead service for the initiative is the Directorate-General for Communications Networks, Content and Technology, Unit C2 Quantum Technologies.

The initiative was validated in DECIDE as a politically sensitive and important new legislative initiative requiring an impact assessment. The envisaged instrument is a proposal for a Regulation of the European Parliament and of the Council establishing an EU Quantum Act.

The initiative was announced in the Competitiveness Compass and constitutes the principal legislative follow-up to the Quantum Europe Strategy, adopted by the Commission on 2 July 2025. It is included in Annex I, policy objective 3 "Research and Innovation", of the Commission Work Programme 2026, which lists the Quantum Act as a legislative initiative with an indicative legal basis under Articles 173, 180 and 184 TFEU and an indicative adoption date in the fourth quarter of 2026.

The DECIDE planning reference is PLAN/2024/2881.

As this is a new initiative, no evaluation of an existing Quantum Act was available. In accordance with the evaluate-first principle, the assessment draws on available evaluations, implementation evidence and administrative data concerning the relevant Union programmes and instruments, including EuroHPC, the Chips Joint Undertaking, Horizon Europe, the Digital Europe Programme, EuroQCI, Union financial instruments and cybersecurity and economic-security frameworks.

6. ORGANISATION AND TIMING

The preparation of the impact assessment began in 2025. An Inter-Service Group was established under the coordination of DG CNECT.

The services involved included the Secretariat-General, the Legal Service, DG BUDG, DG COMP, DG DEFIS, DG FISMA, DG GROW, DG HOME, DG REGIO, DG RTD, DG SANTE, DG TRADE and the Joint Research Centre. DG ENER, DG HR and other services were consulted where their responsibilities were directly relevant to particular measures or impacts.

The first Inter-Service Group meeting took place on 24 September 2025. The Group was subsequently consulted through meetings, written exchanges and review of the consultation material, evidence-gathering activities, intervention logic, policy measures, cost assumptions and draft Impact Assessment Report.

The draft Impact Assessment and policy options were presented to the Inter-Service Group on 17 July 2026. The draft minutes and the consolidated Impact Assessment Report were circulated for written comments on 22 July 2026, with a deadline of 10 August 2026. Comments received through the Inter-Service Group were assessed and reflected in the package before submission to the Regulatory Scrutiny Board.

6.0. CONSULTATION ARRANGEMENTS

An exception from the standard twelve-week public-consultation process was approved by the Secretariat-General. The consultation strategy combined:

- a four-week Call for Evidence;
- targeted consultations with Member States, industry, research organisations, infrastructure operators, financial actors, public users and technical experts;

- interviews, surveys and evidence-gathering activities conducted as part of the external support study; and
- stakeholder contributions and position papers submitted outside the Have Your Say portal.

The English-language Call for Evidence opened on 29 October 2025 and closed on 26 November 2025. Translated language versions remained open until 17 December 2025.

The shortened consultation approach reflected the technical and specialised nature of the initiative and the need to obtain detailed input from the organisations directly involved in quantum research, industrialisation, deployment, finance, standardisation, cybersecurity and supply chains. The approved exception and the measures taken to ensure transparency, accessibility and representation are further described in Annex 2.

The exception was approved by the Secretariat-General on the 7th of March 2025.

6.1. PRINCIPAL PROCEDURAL MILESTONES

Milestone	Date
Establishment and first meeting of the Inter-Service Group	24 September 2025
Opening of the Call for Evidence	29 October 2025
Closure of the Call for Evidence	15 December 2025
Inter-Service Group meeting on the draft IA	17 July 2026
Circulation of the draft IA and minutes for written comments	22 July 2026
Deadline for Inter-Service Group written comments	10 August 2026
Submission of the draft IA to the Regulatory Scrutiny Board	03 September 2026
Regulatory Scrutiny Board meeting	23 September 2026
Regulatory Scrutiny Board opinion (Ref. Ares(2026)9080263)	25 September 2026

Table 1.1. *Principal procedural measures*

The Regulatory Scrutiny Board dates are those recorded in the Board's opinion (meeting of 23 September 2026; opinion signed on 25 September 2026).

7. CONSULTATION OF THE REGULATORY SCRUTINY BOARD

The draft Impact Assessment Report, its executive summary, the public annexes, the minutes of the final Inter-Service Group meeting and the relevant underlying analytical material were submitted to the Regulatory Scrutiny Board.

Where necessary, commercially confidential or security-sensitive supporting evidence were transmitted separately through an appropriate secure channel.

The Board met on 23 September 2026 and delivered a positive opinion with reservations on 25 September 2026.
Table 1.2 sets out how the Board's recommendations have been addressed in the Impact Assessment Report and its annexes.

Board recommendation	Changes made	Location
C(1) Problem and drivers: comparative analysis of main competitors; evolution and maturity of quantum domains; drivers of the scale-up	The updated problem definition compares the EU with its main competitors, in particular the US and China, on public support, private financing and recent policy measures. It sets out the technological and market maturity of each quantum domain and its expected evolution, with firm-level evidence on commercialisation	Main Report: Sections 1.1 (Table 1.1), 2.1 (Table 2.1), 2.3, 2.4, 3.2 and 3.3 Annex 7: From lab to fab (Figure 7.3) Annex 11: Tables 11.1–11.21

gap and scope for public intervention	and on the later-stage financing gap that limits scale-up. The updated problem drivers identify the market and coordination failures that justify public intervention, such as information asymmetry in later-stage finance and the first-buyer and security externalities, and the extent to which existing instruments address them. Annex 7 now explains better the maturity, the lab-to-fab gap and stage gates; Annex 11 provides the supporting data.	
C(2) Dynamic baseline: all relevant national and EU measures; future technological developments, in particular AI	The dynamic baseline covers the actions under the Quantum Europe Strategy, recent and forthcoming horizontal initiatives, and national strategies, programmes and infrastructures adopted or sufficiently advanced, as illustrated for France and the Netherlands. Initiatives proposed or adopted up to 30 September 2026 are considered qualitatively. Interactions with enabling technologies, in particular AI, are assessed, and the expected developments and residual gaps are set out by intervention dimension. Only effects additional to the baseline are attributed to the options; a stronger baseline and lower and higher participation are tested in the sensitivity analysis.	Main Report: Sections 5.1.1 and 5.1.2 (Table 5.1) Annex 4 Part A: Dynamic baseline and attribution; Analytical boundary and treatment of the baseline Annex 4 Part C: Table 4.27 Annex 9: Purpose and scope
C(3) Coherence and synergies with the European Innovation Act, the Public Procurement Act, Chips Act 2 and the ERA Act	The four initiatives are mapped, together with the Cloud and AI Development Act, EU Inc. and STEP, among the existing Union instruments, with the division of functions: they improve the general conditions for innovation, procurement, R&I coordination and semiconductor and digital infrastructure, but do not provide an integrated quantum-specific approach. Their expected effects form part of the dynamic baseline and are not attributed to the Quantum Act. For each initiative, Annex 9 sets out the residual issue, the complementary measures (PM7 for innovation procurement; PM1–PM3 and PM9 for R&I coordination; PM4–PM6 for semiconductor, cloud and AI capabilities) and the non-duplication safeguard.	Main Report: Sections 1.2 (Table 1.2) and 5.1 (Table 5.1) Annex 9: Table 9.1; Interfaces requiring coordinated implementation
C(4) Pathways, bottlenecks and milestones; roles and responsibilities; synergies between PM3, PM5 and PM7 and between the support structures PM4, PM6, PM10, PM12 and PM16; one-stop shop; reuse of existing structures	Each measure is now better described with its content, the bodies responsible and its links to other measures. Grand Challenges (PM3) target key technological and engineering bottlenecks, with measurable objectives, milestones and stage gates. Figure 5.2 and the accompanying text set out the pathway from research to adoption and the synergies along the innovation chain (PM3, PM5, PM7) and between the support structures. The Centres (PM6) are the first entry point for users in each Member State and refer them to infrastructures, the Hubs (PM4), financing, including through the Investment Service Desk (PM10), skills and procurement opportunities; the Business Platform (PM12) connects with the Centres and the Service Desk, and the Alliance (PM16) is linked to the Quantum Strategy Board. Implementation relies on existing bodies, with no new Union body or agency, and the Commission's role is set out by function.	Main Report: Sections 5.2.2 (Figure 5.2), 5.2.6 and 7.4 Annex 4: Tables 4.4–4.6; Table 4.15 Annex 7: Stage-gates (Figure 7.3) Annex 8: Tables 8.1 and 8.12 Annex 9: Interfaces requiring coordinated implementation

C(5) Substantiate assumptions that are not self-explanatory (e.g. the voluntary participation share); report cost and saving calculations in sufficient detail	Each material assumption is now registered with its definition, denominator, low, central and high values, source and use, including the 55% voluntary-participation share and the 64% coordination-adoption share. Commission and Member State staffing is set out by option, and Commission staffing by measure and by function, with the basis of each estimate. Every monetised saving line is shown with its calculation and a worked example, and every cost line is calculated by option and reconciled with the totals and with the distribution by bearer. The material assumptions, including the participation shares, are tested through scenario, switching-value and probabilistic analysis.	Annex 4 Part B: Tables 4.7–4.18 Annex 4 Part C: Tables 4.19–4.30 Annex 3: Tables 3.3 and 3.4

Table 1.2. *How the Board's recommendations have been addressed*

8. EVIDENCE, SOURCES AND QUALITY

The Impact Assessment draws on five principal categories of evidence:

1. **Stakeholder consultation evidence**, including the Call for Evidence, targeted consultations, interviews, workshops, surveys and position papers. The consultation methodology and results are presented in Annex 2.
2. **External analytical support**, including the study undertaken by PPMI/d-fine in support of the Quantum Act Impact Assessment. The study provided evidence and analytical support concerning the quantum ecosystem, infrastructures, investment, procurement, skills, standards, supply chains and policy impacts.
3. **Union and national administrative and programme data**, including information from Horizon Europe, the Digital Europe Programme, EuroHPC, the Chips Joint Undertaking, EuroQCI, relevant financial instruments and Member State strategies and programmes.
4. **Targeted Commission-services analysis**, including mapping of infrastructures, firms, financing rounds, procurement and deployment schemes, standardisation activities, skills, critical components and documented supply-chain effects.
5. **Published research and market evidence**, including the Quantum Europe Strategy, the Strategic Research and Industry Agenda 2030, JRC, OECD/EPO and EIB analyses, academic literature and market-monitoring sources.

The Cost-Benefit Analysis (CBA) workbook provides the quantitative basis for the Main Report and Annexes 3, 4 and 8. The model uses real 2024 prices, a 3% real discount rate and a 2028–2037 assessment period. It distinguishes societal resource costs, administrative burdens, budget appropriations, programme envelopes and transfers and scenario-only effects to avoid double counting.

The evidence was triangulated across sources wherever possible. The assessment distinguishes between:

- observed data;
- stakeholder evidence;
- proxies;
- modelling assumptions;
- illustrative scenarios; and
- analytical judgements.

Evidence quality differs across the quantum domains. Company, investment and procurement databases are not exhaustive; infrastructure-access information does not necessarily measure actual utilisation or available capacity; standardisation activity includes

both published standards and work in progress; and supplier and dependency information may be incomplete or commercially sensitive.

The Impact Assessment therefore avoids aggregating datasets with different scopes and reference periods and does not present scenario estimates as forecasts. Low, central and high assumptions are used where robust point estimates are unavailable. Detailed methodologies, formulas, assumptions, limitations and sensitivity analysis are presented in Annex 4 and in the supporting calculation workbook. Structure of the Impact Assessment documentation

The Impact Assessment package comprises two substantive public Staff Working Documents, a separate executive-summary Staff Working Document, two supporting analytical workbooks and one restricted evidence pack.

Document	Status	Content
Quantum Act IA – Executive Summary	Normal/public	Reader-friendly summary of the problem, objectives, options, principal impacts, preferred option and monitoring arrangements.
Quantum Act IA – Main Report	Normal/public	Problems, objectives, options, impacts, comparison, preferred option and monitoring.
Quantum Act IA – Annexes	Normal/public	Annexes 1–10: procedural information; stakeholder consultation; who is affected and how; analytical methods and cost model; competitiveness check; SME check; key technical concepts; detailed implementation and impacts; coherence with existing EU legislation and initiatives; monitoring and evaluation framework.
Quantum datasets workbook	Supporting analytical file / Annex 11	Datasets supporting the problem definition, dynamic baseline and impact analysis, with stable worksheet names or identifiers used in the public documents.
Restricted Evidence Pack	Limited circulation	Commercially confidential, company-level, supplier-level or security-sensitive supporting evidence transmitted through an appropriate secure channel.

Table 1.3. *Document packages description*

Annex numbering runs continuously across the public annex documents. Annexes 1–10 appear in the document titled “Annexes”. The supporting quantum datasets constitute Annex 11.

The Restricted Evidence Pack is not part of the public Staff Working Documents. It contains only evidence whose disclosure could prejudice commercial interests, reveal security-sensitive supply-chain information, identify confidential consultation participants or undermine the purpose of the analysis.

The public documents present aggregated findings, methodologies, limitations and sufficient information to understand how restricted evidence was used. References to restricted material use stable evidence identifiers without reproducing confidential content. Access is limited to authorised Commission services and, where required for scrutiny, the Regulatory Scrutiny Board.

ANNEX 2: STAKEHOLDER CONSULTATION (SYNOPSIS REPORT)

9. PURPOSE AND CONSULTATION OBJECTIVES

This annex summarises the stakeholder consultation activities conducted in preparation of the Impact Assessment for the EU Quantum Act. It describes the consultation strategy, participants and analytical methods; presents the principal findings and divergent views; and explains how the evidence influenced the problem definition, policy options and design of the preferred option.

The consultation sought to:

- test the Commission's understanding of the problems affecting the European quantum ecosystem;
- collect evidence on fragmentation, lab-to-fab barriers, infrastructure access, scale-up finance, demand, skills, standards, quantum-safe preparedness and strategic dependencies;
- assess the feasibility, expected benefits, costs and risks of possible Union action;
- identify differences between quantum-computing, communication, sensing and enabling-technology ecosystems;
- examine the appropriate balance between voluntary coordination and targeted obligations; and
- identify proposals that should not be pursued because of insufficient evidence, disproportionate burdens, overlap with existing instruments or legal and implementation constraints.

Stakeholder evidence informed the Impact Assessment but was not treated as a representative opinion poll. Consultation findings were assessed together with programme data, market and company mappings, infrastructure and supply-chain evidence, published research and Commission-services analysis.

10. CONSULTATION STRATEGY AND ACTIVITIES

10.0. CONSULTATION APPROACH AND MINIMUM STANDARDS

An exception from the standard twelve-week public-consultation process was approved by the Secretariat-General. The consultation strategy combined a four-week Call for Evidence with targeted interviews, an industry survey, exchanges with Member States and stakeholders, and the analysis of position papers.

This approach reflected the specialised and partly pre-commercial nature of quantum technologies. Many of the relevant questions concerned technical infrastructure, investment, procurement, standards, cryptographic migration and commercially sensitive supply chains. Targeted activities were therefore necessary to complement the open feedback mechanism and obtain sufficiently detailed operational evidence.

The main Better Regulation consultation principles were respected:

- **transparency:** the Call for Evidence explained the problems, possible measures, expected impacts and consultation approach;
- **accessibility:** the Call for Evidence was published through the Have Your Say portal and made available in the Union's official languages;
- **openness:** individuals and organisations could submit feedback and supporting documents;
- **targeted coverage:** specific outreach was undertaken to industry, SMEs, research organisations, Member States, infrastructure operators, investors, standards organisations and implementing bodies;

- **data protection and confidentiality:** publication choices were respected, interview transcripts were anonymised and commercially sensitive information was aggregated; and
- **feedback:** the principal consultation findings and their use in policy design are explained in this annex and reflected in the Impact Assessment Report.

The English-language Call for Evidence opened on 29 October 2025 and closed on 26 November 2025. Translated versions remained open until 17 December 2025.

10.1. OVERVIEW OF CONSULTATION ACTIVITIES

Activity	Participation	Timing	Principal purpose
Call for Evidence	228 inputs: 216 portal submissions and 12 additional papers	29 October–17 December 2025	Test the problem definition, possible measures and impacts; receive supporting evidence and position papers
Targeted interviews	32 interviews from 74 invitations	2 February–24 March 2026	Explore problem drivers, implementation constraints, costs, risks and policy design
Industry survey	41 responses from 418 invitations	25 February–16 March 2026	Gather structured evidence from companies on financing, infrastructure, demand, dependencies and possible measures
Member State engagement	Five Member State authorities interviewed, complemented by exchanges through established quantum-policy and programme channels	2025–2026	Test subsidiarity, governance, national-programme interaction and implementation feasibility
Stakeholder and expert exchanges	Industry, research, infrastructure, cybersecurity, finance and standards stakeholders	2025–2026	Validate specific measures and evidence, including PQC, standards, procurement and supply-chain resilience
Targeted/ad hoc technical contribution	European Patent Office	March-15 July 2026	The European Patent Office provided an ad hoc technical contribution on the quantum patent landscape.

Table 2.1. *Consultation activities*

10.2. PARTICIPANTS AND ANALYTICAL METHODOLOGY

10.2.1. Call for Evidence participants

The Call for Evidence dataset contains 228 inputs. Of these, 132 included an attachment. Twenty-nine substantive position papers were extracted for a separate attachment-level qualitative review after quality-control and de-duplication.

Portal categories were consolidated for analytical presentation. The original labels do not always identify the substantive interest represented: for example, some individuals submitted contributions on behalf of companies, research bodies or other organisations.

Stakeholder category	Number of inputs	Share
Businesses	56	24.6%
Business and industry associations	24	10.5%
Academic and research organisations	44	19.3%
Citizens	52	22.8%
NGOs, civil-society organisations and trade unions	20	8.8%

Public authorities	8	3.5%
Other, including networks and technical organisations	24	10.5%
Total	228	100%

Table 2.2. *Call for Evidence respondents by consolidated category. Commission-services analysis of the Call for Evidence classification dataset. Categories have been consolidated from the original Have Your Say classifications.*

Of the 228 submissions, 197 originated in the EU, 30 outside the EU and one did not identify a country. The highest numbers of contributions came from Germany (44), Italy (26), France (22), Belgium (18), the Netherlands (17), Spain and the United States (12 each), and Austria (11). The geographic distribution reflects the concentration of existing quantum ecosystems and active stakeholder networks and should not be interpreted as representative of population or market size.

No mass-response campaign was identified. The dataset included some coordinated contributions and cases where the same or substantially similar supporting document was submitted by more than one respondent. Individual submissions were retained in the participation counts, while identical or near-identical attachments were counted once in the attachment-level qualitative synthesis to avoid double weighting.

10.3. TARGETED INTERVIEWS

The external study conducted 32 semi-structured interviews.

Stakeholder group	Interviews
Member State authorities	5
EU bodies or EU-supported programmes	4
Industry representatives	10
Industry associations	4
Research and academic organisations	4
Standards organisations	2
Investors	3
Total	32

Table 2.3. *Interviews by stakeholder group*

Before each interview, participants received a topic note aligned with the intervention logic. Interviews covered governance, infrastructure, financing, market uptake, skills, standards, supply chains, expected impacts, costs and monitoring indicators.

Transcripts were anonymised and coded using a common taxonomy covering:

- fragmentation of governance and funding;
- lab-to-fab and infrastructure-access bottlenecks;
- scale-up investment and de-risking;
- demand, procurement, standards and user support;
- strategic dependencies and leakage risks;
- skills and uneven access;
- proposed policy measures;
- expected positive and negative impacts; and
- monitoring indicators.

Digital tools were used to support the organisation and comparison of coded material. All coding, interpretation and synthesis were reviewed by the study team.

10.4. INDUSTRY SURVEY

The survey received 41 responses from organisations in 13 Member States. Thirty-three responses, or approximately 80%, came from micro, small or medium-sized organisations.

Organisation size	Responses
Micro, 1–9 employees	12
Small, 10–49 employees	14
Medium, 50–250 employees	7
Large, 250–999 employees	4
Very large or global enterprise	3
Other	1
Total	41

Table 2.4. *Survey respondents by organisation size*

Germany accounted for 13 responses, France and the Netherlands for five each, Finland for three, and Austria, Denmark, Ireland, Italy, Romania and Sweden for two each. Croatia, Slovenia and Spain accounted for one response each. Closed questions were analysed quantitatively. Open answers were coded using the same broad taxonomy as the interview material, allowing comparison between consultation channels.

10.5. CALL FOR EVIDENCE CLASSIFICATION

Call for Evidence inputs were classified through a multi-tag taxonomy covering policy pillars, policy areas, instruments, value-chain stages, application sectors and impact dimensions. Each contribution could receive several tags.

Policy area	Inputs tagged
Funding and grants	205
Infrastructure, testbeds and pilots	157
Market creation and procurement	134
Supply chains, resilience and economic security	125
Governance and coordination	119
International cooperation	107
Investment and finance	97
Security, cryptography and cybersecurity	97
Standards, certification and interoperability	92
Skills, education and mobility	85

Table 2.5. *Most frequent policy-area tags in Call for Evidence inputs. Source: Call for Evidence classification dataset.*

Because multiple tags could be assigned to a contribution, the figures are not additive and do not constitute votes in favour of particular measures. They indicate the prevalence of issues discussed.

10.6. TARGETED/AD HOC TECHNICAL CONTRIBUTIONS

The European Patent Office provided an ad hoc technical contribution on the quantum patent landscape, dated 15 July 2026. The contribution informed the assessment of scale-up and value-capture conditions, patent intelligence, finance readiness and participation in standardisation. It was treated as technical evidence rather than as an expression of stakeholder preference between policy options.

The High-Level Board on Quantum Technologies supported a lifecycle approach linking scientific excellence, technology maturation, infrastructure access, procurement, deployment and scale-up finance. It recommended milestone-based Grand Challenges, a limited number of specialised Innovation Hubs connected to distributed competence or access points, stronger first-buyer pathways and safeguards against forced SME consortia or unnecessary disclosure of commercially sensitive information. These recommendations informed the detailed PO2 design. Its stronger proposals dedicated risk-bearing investment capacity, stronger strategic procurement conditions, targeted mandatory assurance, wider targeted dependency information requirements and binding PQC-preparedness duties for defined critical actors were considered through PO3.[1]

10.7. LIMITATIONS

The consultation evidence has several limitations:

- participation was voluntary and self-selected;
- the Call for Evidence did not use a structured questionnaire;
- some stakeholder categories and Member States were more strongly represented than others;
- the industry survey had 41 responses and was not statistically representative;
- interview participants were purposively selected for expertise rather than randomly sampled;
- contributions differed significantly in length and level of detail;
- organised stakeholders generally had greater capacity to submit detailed position papers;
- commercially sensitive information could not always be reproduced in the public analysis; and
- frequency of mention does not indicate the economic importance of an issue or support for a specific policy instrument.

The consultation findings were therefore used primarily to identify issues, test causal mechanisms, understand implementation constraints and capture divergent positions. Quantitative problem indicators and impact estimates were derived from the wider evidence base.

11. PRINCIPAL CONSULTATION FINDINGS

11.0. OVERVIEW

The different consultation channels broadly confirmed three structural problems, which are detailed in Chapter 2 of the Impact Assessment:

1. slow conversion of research excellence into deployable technologies;
2. insufficient conditions for firms to scale and for early markets to develop; and
3. strategic dependencies and insufficient resilience.

They also supported the seven drivers identified in the main report: insufficient strategic alignment, uneven access to industrialisation infrastructure, skills gaps, financing discontinuities, weak demand pull, incomplete standards and assurance pathways, and limited visibility of dependencies.

Theme	Interviews	Industry survey
Governance or institutional design	32/32	—
Lack of EU–Member State coordination	30/32	16/41

[1] Draft Second Report on Quantum Act Priorities, July 2026, produced by the Top-Level Specialists in Quantum Technologies Commission expert group.

Funding instruments and financial mechanisms	29/32	20/41
Lack of strategic EU-level priorities	25/32	—
Dependence on non-EU suppliers	24/32	20/41
Absence of late-stage capital	23/32	27/41
Positive effects expected from stronger coordination	22/32	—
Risks or negative impacts from stronger intervention	21/32	—
Insufficient or inefficient public funding	21/32	8/41
Procurement and demand-side measures	20/32	10/41
Lack of de-risking mechanisms	—	19/41
Skills and workforce constraints	—	19/41
Infrastructure development and access	—	10/41
Lack of accessible testbeds or pilot lines	—	9/41

Table 2.6. *Selected quantitative findings from targeted consultation. Source: PPMI/d-fine interview and survey coding. A respondent could be coded under several themes.*

11.1. COMPARISON ACROSS CONSULTATION CHANNELS

Theme	Common finding across channels	Complementary evidence	Main divergence
Coordination	Fragmented EU and national action limits scale and coherence	Interviews provided examples of parallel planning and unclear institutional interfaces	Dedicated institution versus coordination through existing structures
Lab-to-fab and access	Firms, particularly SMEs, face access and qualification barriers	Interviews identified contractual, cost and facility-design problems	Some survey respondents considered existing capacity sufficient in their domain
Finance	Growth-stage capital and financing continuity are insufficient	Investors explained lead-investor, valuation and public-private risk-sharing issues	Dedicated quantum fund versus thematic use of existing instruments
Demand	Public procurement can create reference markets and early revenues	National procurement examples illustrated possible delivery models	General "Buy European" preference versus open, risk-based procurement
Standards and trust	Common benchmarks and testing references would support uptake	Standards organisations identified sequencing and measurement requirements	Horizontal certification versus maturity-dependent targeted assurance
PQC	Coordinated preparation and technical support are needed	Cybersecurity actors stressed links with existing EU frameworks	Broad support for technical coordination; divergent views on binding planning or procurement obligations.
Dependencies	Better visibility and mitigation of critical dependencies are needed	Industry identified component categories and qualification constraints	Strategic autonomy through restrictions versus openness and diversification
Skills	Industrial, engineering and user-side skills require attention	SMEs stressed practical recruitment and training barriers	Broad educational or visa measures versus targeted deployment-linked action

Table 2.7. *Consistency, complementarity and divergence*

11.2. FEEDBACK AND FUTURE USE OF CONSULTATION EVIDENCE

The consultation results have been incorporated into the problem definition, option design, impact assessment, SME analysis, competitiveness check and monitoring framework.

Following adoption of the initiative, the synopsis report will be published with the Impact Assessment. Contributions submitted through the Have Your Say portal remain available in accordance with respondents' publication choices and applicable data-protection rules.

Monitoring will continue to involve Member States, industry, research organisations, infrastructure operators, investors, standards bodies, buyers and users. The first implementation review will assess whether the measures address the practical barriers identified during consultation and whether the reporting, access, funding and procurement arrangements create unintended or disproportionate burdens, particularly for SMEs and smaller public administrations.

ANNEX 3: WHO IS AFFECTED AND HOW?

12. PRACTICAL IMPLICATIONS OF THE INITIATIVE

The preferred option primarily affects the Commission, Member States, Union implementing bodies, designated or Union-supported infrastructures and projects, and businesses participating in support, procurement or project activities.

Most obligations fall on public authorities, implementing bodies and actors receiving or applying for support. For businesses, participation in most measures is voluntary. Binding requirements are limited to clearly defined cases, notably reporting or information obligations linked to supported activities, designated projects, supported procurement or targeted strategic-intelligence requests. The initiative does not impose direct obligations on citizens or consumers.

The preferred option is therefore expected to generate mainly administrative and implementation costs for public authorities and implementing bodies, while business-facing costs are concentrated on applicants, beneficiaries and other directly participating actors. Around 65% of the modelled PO2 societal costs fall on Commission/Union services and Member State authorities; including implementing bodies, facility operators and Commission-financed experts, around 92% falls on the public and implementation side.

Stakeholder group	Main practical implications
Commission and Union services	Operate the Quantum Strategy Board and common programming/review cycle; coordinate Strategic Projects, infrastructure, finance, procurement, standards, strategic intelligence and monitoring; maintain common methods, templates and data systems.
Member State authorities and public buyers	Participate in governance and programming; contribute to national quantum planning and implementation; cooperate on procurement, skills, PQC and resilience; provide information for the biennial PQC preparedness assessment, take part in coordinated PQC exercises and apply PQC requirements in public procurement; provide proportionate information where required.
Implementing bodies, Joint Undertakings and agencies	Administer relevant calls, access arrangements and projects; support implementation and monitoring; assess milestones and coordinate with the Commission and Member States within their existing mandates.
Infrastructure and Centre operators	Provide additional access, user-support, testing, validation and referral services where selected or supported; adapt existing services where necessary.
Businesses, including start-ups and SMEs	Mainly voluntary participation in funding, infrastructure access, finance, procurement, standards, matchmaking and support measures. Targeted information obligations may apply to beneficiaries, designated projects or actors in clearly defined critical categories; suppliers bidding in public procurement that sets PQC requirements provide evidence of compliance.
Investors and financial institutions	Participate voluntarily in investment-readiness, syndication and financing activities; individual investment and due-diligence decisions remain with the competent institutions and investors.
Citizens and consumers	No direct administrative or compliance obligations. Potential benefits are indirect and depend on successful future deployment of quantum technologies.

Table 3.1. Practical implications by stakeholder group

The existing analysis already identifies these actor groups and distinguishes business participation from public-sector implementation responsibilities.

13. SUMMARY OF COSTS AND BENEFITS

The preferred option is expected to generate direct administrative and transaction-cost savings and wider benefits through improved coordination, infrastructure access, financing continuity, demand formation, standards and assurance, skills and supply-chain resilience.

Only benefits supported by sufficiently explicit causal mechanisms and data are monetised. Wider effects on industrial capacity, innovation, firm growth, employment, productivity, resilience and security are assessed qualitatively or through scenarios and are not aggregated into a single monetary benefit estimate. This avoids double counting and reflects the substantial uncertainty surrounding the development and uptake of quantum technologies.

I. Overview of Benefits (total for all provisions) – Preferred Option		
Description	***Amount***	***Comments***
Direct benefits		
Administrative and transaction-cost savings	EUR 13.59 million NPV	Modelled time and transaction-cost savings under PO2 comprise approximately EUR 6.86 million for Member State authorities, EUR 6.45 million for businesses and EUR 0.27 million for implementing bodies.
Improved infrastructure access	Not robustly monetisable	Common access arrangements, referrals and user support may reduce search, negotiation and waiting costs and accelerate access to engineering, testing, validation and qualification. Illustrative scenarios are reported separately and are not added to the monetised total.
Improved access to scale-up finance	Not robustly monetisable	Better investment readiness, referrals and cross-border syndication may improve financing continuity. Financing volumes are treated as activity indicators, not welfare benefits.
Improved demand and first-buyer pathways	Not robustly monetisable	Coordinated innovation procurement and reference deployments may generate earlier revenues, customer validation and stronger investor confidence. Effects depend on buyer participation and technological maturity.
Indirect benefits		
Industrial capability and innovation	Not robustly monetisable	Improved continuity from research to industrial validation and deployment may strengthen European industrial capacity and value capture.
Standards, benchmarking and trusted deployment	Not robustly monetisable	Common terminology, benchmarks, test methods and interoperability profiles may reduce repeated due diligence and improve comparability and trust.
Skills and user capability	Not robustly monetisable	Training, mobility and user-support measures may improve availability of technical, industrial and deployment skills.
Supply-chain resilience	Not robustly monetisable	Earlier identification of dependencies and support for diversification and supplier qualification may reduce disruption risks and technical lock-in.
Wider societal benefits	Not robustly monetisable	Potential benefits in areas such as health, energy, security, navigation and environmental monitoring depend on the successful development and deployment of specific quantum applications and cannot be attributed fully to the Act.

Table 3.2. *Overview of benefits (preferred option)*

The EUR 13.59 million total is the modelled monetised saving for PO2; the wider benefit channels are already set out in the existing Annex 5 analysis.

II. Overview of costs – Preferred option (PO2), EUR million, net present value 2028–2037							
		Citizens/Consumers		**Businesses**		**Administrations**	
		One-off	**Recurrent**	**One-off**	**Recurrent**	**One-off**	**Recurrent**
Action (a): conditions attached to Union funding (PM1b project metadata; PM3b stage-gate reporting)	Direct administrative costs	Not applicable	Not applicable	0.20	1.89	Not applicable	Not applicable
Action (b): Strategic Project designation (PM5b applications, reporting and safeguards)	Direct administrative costs	Not applicable	Not applicable	Not applicable	0.92	Not applicable	Not applicable

Action (c): supported innovation procurement and PQC requirements in public procurement (PM7b documentation of origin by bidders; PM13b evidence of PQC compliance)	Direct administrative costs	Not applicable	Not applicable	Not applicable	1.29	Not applicable	Not applicable
Action (d): targeted information requests (PM11b dependency information)	Direct administrative costs	Not applicable	Not applicable	0.05	0.43	Not applicable	Not applicable
Action (e): taking part in regulatory sandboxes, the business platform or investment support (PM6b, PM12b, PM10b)	Direct administrative costs (sandbox participation; platform onboarding; documentation for investment transactions)	Not applicable	Not applicable	0.04	0.68	Not applicable	Not applicable
Action (f): governance, programming, monitoring and enforcement by public authorities (all measures)	Direct administrative costs (Member State authorities 26.06; implementing bodies 1.60)	Not applicable	Not applicable	Not applicable	Not applicable	1.08	26.59
	Direct enforcement costs (Commission 3.98; Member State authorities 1.35)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	5.33
	Direct enforcement costs: implementation (Commission administration 25.65; Commission non-staff resources 8.44; implementing-body delivery 4.67; external experts 0.55)	Not applicable	Not applicable	Not applicable	Not applicable	4.67	34.63
Action (g): Hub and Centre services (PM4b, PM6b; existing, publicly funded operators)	Direct enforcement costs: implementation (Centre adaptation; hub services)	Not applicable	Not applicable	Not applicable	Not applicable	4.37	17.04

Action (h): measures that Member States may opt into (PM7b joint innovation procurement; PM13b PQC expert support)	Direct enforcement costs: implementation by Member State authorities	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	3.40
Other: participation by firms without a legal requirement (PM16b Alliance input; PM8b standards, testing and advisory work; PM12b platform input and matchmaking; PM13b expert time)	Not a compliance cost; part of the societal cost	Not applicable	Not applicable	Not applicable	3.33	Not applicable	Not applicable
Total (EUR 105.92 million)	**All cost types**	**Not applicable**	**Not applicable**	**0.29**	**8.54**	**10.12**	**86.97**
Memorandum: transfers (not included above)		Programme expenditure, grants, procurement contracts and financial-instrument capital are transfers. Indicative Union programme resources for 2028–2034: EUR 5.19–6.12 billion, nominal (Annex 4, Part D).					

Table 3.3. *Overview of costs – Preferred option*

The table above sets out the full incremental costs of the preferred option by actor and action. Detailed calculations, assumptions, affected populations, unit costs and sensitivity ranges are provided in Annex 4. Programme expenditure, grants, procurement expenditure and financial-instrument capital are transfers; they are reported separately (Annex 4, Part D) and are not included in the costs above.[2]

Values are central net present values for 2028–2037 (EUR million; 3% discount rate; base year 2028). The rows add up to the total societal cost of PO2 (EUR 105.92 million): EUR 8.83 million for businesses and EUR 97.09 million for administrations, which cover the Commission, Member State authorities, implementing bodies, Commission-financed external experts and the existing Hub and Centre operators; these operators are publicly funded. Business administrative costs (EUR 5.50 million) arise only where a firm receives Union funding (EUR 2.10 million: PM1b project metadata from 180 funded beneficiaries, EUR 1.91 million including a one-off set-up of EUR 0.20 million; PM3b stage-gate reporting by 15 funded consortia, EUR 0.19 million), seeks designation as a Strategic Project (EUR 0.92 million: applications EUR 0.33 million, reporting EUR 0.48 million, safeguards EUR 0.10 million), bids in supported innovation procurement (EUR 0.07 million) or in public procurement that sets PQC requirements (EUR 1.23 million), receives a targeted information request on dependencies (EUR 0.48 million) or takes part in a regulatory sandbox, the business platform or investment support (EUR 0.72 million: sandbox participation EUR 0.64 million, platform onboarding EUR 0.04 million, documentation for investment transactions EUR 0.05 million). EUR 5.46 million of these costs fall within One-In, One-Out (Table 3.4); the documentation for investment support is an application for financial support and is not offset (Tool #58, Box 4). The one-off business cost is EUR 0.29

[2] Central estimates, real 2024 prices, 2028–2037. The business administrative-cost total is EUR 5.50 million NPV (EUR 5.46 million within One-in, One-out), including EUR 0.29 million NPV in one-off administrative burden. The administration figures comprise Member State/public-administration and implementing-body administrative costs. The administrations' columns cover the Commission, Member State authorities, implementing bodies, Commission-financed external experts and the existing Hub and Centre operators, which are publicly funded. Small differences may arise from rounding. Total societal cost under PO2 is EUR 105.92 million NPV. Programme expenditure, grants, procurement expenditure and financial-instrument capital are reported separately and are not included as regulatory compliance costs.

million NPV (EUR 0.30 million nominal). Commission administration and resources, implementing-body delivery, experts, the Hub and Centre resources and the effort of Member State authorities in measures that the act enables but does not require (EUR 3.40 million) are implementation costs, shown as enforcement costs. Time that firms choose to spend in the new structures without any legal requirement (EUR 3.33 million) is not a compliance cost; it is shown separately because it is part of the societal cost. PO2 creates no adjustment costs and no regulatory fees or charges. Small differences are due to rounding. Calculations are set out in Annex 4.

III. Application of the 'one in, one out' approach – Preferred option			
[M€]	**One-off** (annualised total net present value over the relevant period)	**Recurrent** (nominal values per year)	**Total**
Businesses			
New administrative burdens (INs)	**0.033**	**0.663**	**0.696**
Removed administrative burdens (OUTs)	0	0	0
Net administrative burdens*	**0.033**	**0.663**	**0.696**
Adjustment costs**	0	0	
Citizens			
New administrative burdens (INs)	0	0	0
Removed administrative burdens (OUTs)	0	0	0
Net administrative burdens*	0	0	0
Adjustment costs**	0	0	
Total administrative burdens***	**0.033**	**0.663**	**0.696**

Table 3.4. *Application of the 'one in, one out' approach – Preferred option*

(*) Net administrative burdens = INs – OUTs;
(**) Adjustment costs falling under the scope of the OIOO approach are the same as reported in Table II above. Non-annualised values;
(***) Total administrative burdens = Net administrative burdens for businesses + net administrative burdens for citizens.
The figures are central estimates. Detailed calculations and assumptions are provided in Annex 4

The preferred option introduces a limited amount of new administrative burden for businesses. These burdens arise from information obligations that apply only to firms that receive Union funding, seek designation as Strategic Project, bid in supported innovation procurement or in public procurement that sets PQC requirements, take part in a regulatory sandbox or the business platform, or receive a targeted information request. Documentation for investment support (EUR 0.05 million), time that firms choose to spend in the new

structures without a legal requirement. Voluntary participation costs, public-administration resources, programme expenditure and transfers are outside the administrative-burden component of the One-In, One-Out calculation. The initiative does not remove existing obligations that qualify as administrative offsets and does not impose administrative burdens on citizens.

The one-off column annualises the one-off burden over 2028-2037 (EUR 0.30 million nominal). The recurrent column gives the average nominal annual burden in the years in which it arises, 2029-2037 (between EUR 0.56 million and EUR 0.72 million a year). On a discounted basis, the business administrative burden is EUR 5.46 million NPV over 2028-2037, equivalent to EUR 0.621 million a year. No administrative burdens are imposed on citizens and no qualifying administrative offsets or business adjustment costs are identified under PO2.

14. RELEVANT SUSTAINABLE DEVELOPMENT GOALS

The preferred option is expected to contribute principally to Sustainable Development Goals 4, 8 and 9.

IV. Overview of relevant Sustainable Development Goals – Preferred Option(s)		
Relevant SDG	**Relevant SDG**	**Relevant SDG**
SDG 4 – Quality education	Positive contribution through quantum skills, training, mobility and user-capability measures.	Effects depend on participation, programme resources and the capacity to address identified skills gaps.
SDG 8 – Decent work and economic growth	Positive contribution through support for firm growth, investment, industrial deployment and specialised employment.	No aggregate employment effect is quantified ex ante because impacts depend on technological and market development.
SDG 9 – Industry, innovation and infrastructure	Strong positive contribution through improved research-to-deployment pathways, shared infrastructure, industrialisation support and innovation uptake.	

Table 3.5. *Overview of relevant sustainable development goals (preferred option)*

15. IMPACTS ON FUNDAMENTAL RIGHTS

Measure	Right or interest affected	Required safeguards
Information requests and reporting	Data protection, trade secrets and freedom to conduct a business	Defined purpose and population, necessity, minimisation, confidentiality, once-only reuse and review rights
Project designation, access and support	Equal treatment, property interests and freedom to conduct a business	Transparent criteria, reasoned decisions, right to be heard, review and withdrawal procedures
Procurement and eligibility conditions	Equal treatment, market access and business freedom	Prior market analysis, proportionality, availability tests and transparent exceptions
Standards and assurance	Technological neutrality and compliance costs	Maturity triggers, phased application, defined scope and periodic review
Security-sensitive participation conditions	Academic freedom, openness of research and international cooperation	Risk-based assessment and distinction between open research and sensitive deployment

Table 3.6. *Fundamental-rights and procedural safeguards*

ANNEX 4: ANALYTICAL METHODS

16. PART A - ANALYTICAL FRAMEWORK

16.0. PURPOSE AND SCOPE

This annex explains the analytical methods used to assess the impacts of the retained policy options for the EU Quantum Act.

It describes:

- the analytical framework and evidence base;
- the treatment of the dynamic baseline;
- the construction of the policy options;
- the methodology used to assess costs and benefits;
- the Standard Cost Model;
- the aggregation of measure-level impacts into option-level results;
- the treatment of programme expenditure;
- the approach to uncertainty and sensitivity; and
- the development, governance, validation and quality-assurance arrangements of the analytical work

Detailed option- and measure-level impacts are provided in Annex 8. Parts B and C of this annex present the detailed cost model, assumptions and sensitivity analysis.

The analysis follows the European Commission's Better Regulation methodology, including the typology of costs and benefits, the Standard Cost Model, discounting and sensitivity analysis. It combines quantitative analysis where a sufficiently robust causal mechanism and data source are available with structured qualitative assessment where monetisation would be speculative or misleading.

The quantitative estimates are central values; Parts B and C set out their low and high values and the sensitivity and probabilistic analysis.

16.1. DEVELOPMENT, GOVERNANCE, VALIDATION AND TRANSPARENCY OF THE ANALYTICAL WORK

The analytical work supporting the Impact Assessment was developed through a combination of external analytical support and Commission-services analysis. The external support study undertaken by PPMI/d-fine was designed to provide a comprehensive evidence base for the assessment of a potential European Quantum Act. Its methodological framework combined quantitative evidence, including statistics, indicators, funding and market data, with qualitative evidence, including stakeholder interviews and surveys. The methodology supported the problem analysis, assessment of impacts and cost-benefit analysis of the policy measures and policy options.

The scope and methodological approach of the external study were developed iteratively with the Commission. The Contractor provided evidence, analytical input, feedback and suggestions as the Impact Assessment evolved, while responsibility for the Impact Assessment, the Policy Option design and the analytical and policy conclusions remained with the Commission. The scope and approach were discussed and refined through meetings and written exchanges with the Commission, including the methodological agreements and successive updates documented in the study.

Validation and quality assurance relied principally on triangulation across different types and sources of evidence. Quantitative data, including statistical indicators and financing data, were assessed alongside qualitative evidence from interviews, surveys and other stakeholder inputs. This approach was used to test the consistency of findings across

evidence sources and to identify areas of uncertainty or divergence. The Commission further assessed the evidence against Union and national programme data, Commission-services analysis and published institutional and academic sources. Assumptions that could not be supported by sufficiently robust point estimates are treated through low, central and high values, sensitivity analysis or explicitly identified qualitative or scenario-based assessment.

Where possible, evidence was disaggregated by Member State or non-EU country and by quantum-technology pillar. The Impact Assessment presents aggregate findings and methodological assumptions, while commercially confidential or security-sensitive underlying evidence is handled separately as described in Annex 1.

16.2. ANALYTICAL FRAMEWORK

The assessment follows the intervention logic established in the Main Report:

problem drivers → problems → specific objectives → policy measures →

policy options → outputs → results → impacts

Each Policy Measure family is linked to one or more problem drivers and specific objectives. Its incremental costs and expected effects are assessed relative to the dynamic baseline through an explicit causal mechanism. Policy measures are then packaged into three mutually exclusive policy options representing increasing intervention intensity.

Step	Principal analytical question	Main output
1. Problem evidence	What is the nature and scale of the problem, and how strong is the evidence?	Baseline indicators, stakeholder evidence and explicit data limitations.
2. Intervention logic	Which drivers can Union action influence?	Section 2.2 in the Impact Assessment Main Report
3. Measure assessment	What activities, actors, costs and outcomes would each PM variant generate?	PM definitions and variants (**Table 4.5** and **Table 4.6**), measure-level impact assessment (**Table 8.4**), and monitoring indicators (**Table 10.4**).
4. Option construction	How do PO1, PO2 and PO3 differ in legal force, coverage and implementation intensity?	PM1–PM16 Policy Measure variant matrix (**Table 4.6**)
5. Impact assessment	What economic, social, environmental, fundamental-rights, governance and implementation impacts are expected?	Monetised results, physical or financial scenarios and qualitative assessment.
6. Option comparison	Which option performs best on effectiveness, efficiency, coherence, proportionality and feasibility?	Structured comparison and transparent MCDA support.
7. Uncertainty testing	Do the conclusions change under plausible alternative assumptions?	Deterministic ranges, infrastructure scenarios, switching values and weight sensitivity.

Table 4.1. *Analytical steps*

16.3. EVIDENCE BASE

The analytical evidence consists principally of:

- the stakeholder consultation described in Annex 2;
- the external PPMI/d-fine support study;
- Union and national programme and administrative data;
- mappings of quantum firms, investments, infrastructures, procurement schemes, standardisation activities, skills and critical components;
- the Quantum Europe Strategy and the Strategic Research and Industry Agenda 2030;
- JRC, EIB, EPO/OECD and other institutional analyses;
- academic evidence on innovation procurement and financing; and

- comparable Union impact assessments and instruments, including the Chips Act, Critical Raw Materials Act and cybersecurity legislation.

Evidence was triangulated across sources where possible. Company, investment, infrastructure and procurement mappings are not exhaustive. Supplier and dependency information is particularly affected by commercial confidentiality and incomplete visibility beyond firms' direct suppliers.

The public analysis therefore presents aggregate results. Detailed commercially confidential or security-sensitive material is placed in the Restricted Evidence Pack.

16.4. ANALYTICAL PERIMETER AND CONVENTIONS

Element	Treatment in the model
Assessment period	2028–2037
Price base	Real 2024 prices
Discount rate	3% per year
Discounting convention	Present value in 2028: $PV = \sum_{t=2028}^{2037} \frac{V_t}{(1+0.03)^{(t-2028)}}$
Policy baseline	Dynamic baseline including existing Union and Member State programmes, infrastructures and already planned measures.
Existing laboratories and facilities	Construction costs and ordinary operating expenditure remain in the baseline.
Existing Chips Act or other competence/acceleration centres	Existing capacity remains in the baseline; only incremental quantum-related adaptation is counted.
One-off costs	Assigned to the expected year in which the obligation or activity begins.
Recurrent costs	Applied annually from the relevant starting year until 2037.
Labour resources	Person-days multiplied by the relevant fully loaded labour-cost rate.
FTE conversion	225 person-days per FTE.
Administrative burdens	Information obligations only, in accordance with the Standard Cost Model.
Adjustment costs	Substantive costs of changing procedures, systems or behaviour, shown separately from information obligations.
Transfers	Grants, vouchers, procurement expenditure and financial commitments are not treated automatically as societal costs.
User fees	Budgetary transfers; they do not affect societal net present value.
Residual value	Included only for eligible durable incremental assets; zero in the central case.
Monetised benefits	Demonstrable time and resource savings only.
Strategic benefits	Assessed qualitatively or through explicitly labelled scenarios.
Main societal-cost perimeter	Core policy machinery plus marginal hub-service and centre-adaptation resources.
PO2 programme-resource envelope	Single bottom-up envelope reported separately in Annex 4; excluded from the Standard Cost Model, option totals and societal-cost calculation.

Table 4.2. *Analytical conventions used in the model*

The model distinguishes three analytical views:

1. **Core policy machinery:** administrative, adjustment, coordination, monitoring, assessment and other real resources required to operate the measures.
2. **Incremental implementation resources:** marginal public-facing services provided through existing hubs and adaptation of existing or suitable Centres.
3. **Total societal cost:** core policy machinery plus incremental implementation resources.

Public-budget expenditure and financing or investment volumes are reported separately. This prevents transfers, financing targets and real-resource costs from being added together.

16.5. DYNAMIC BASELINE AND ATTRIBUTION

All impacts are assessed relative to the dynamic baseline described in Section 5.1 of the Main Report. The baseline includes the expected implementation of the Quantum Europe Strategy; the expanded EuroHPC JU mandate; quantum-chip design, pilot-line and validation activities under the Chips JU; Horizon Europe and the Digital Europe Programme; EuroQCI and related connectivity activities; existing EIC, InvestEU and EIB Group instruments; Member State strategies, programmes and infrastructures; European and international standardisation; the coordinated PQC roadmap; and the existing cybersecurity, foreign-investment-screening, export-control and critical-raw-material frameworks.

Costs and benefits already expected under those instruments are not attributed to the Quantum Act. Only the incremental effects of PO1, PO2 and PO3 are counted. Where an option uses an existing programme, institution, facility or administrative system, the model counts only the additional activity attributable to the Quantum Act, not the historical construction cost or ordinary operation of the underlying programme or institution.

The central infrastructure case assumes reuse of existing laboratories and adaptation of existing or suitable competence and acceleration centres. It includes only marginal public-facing services and quantum-related adaptation. A separate full-build scenario is retained as a stress test and does not represent the central policy design.

The substantive costs of the transition to post-quantum cryptography are included in the baseline because the coordinated roadmap and relevant cybersecurity and sectoral frameworks already establish the policy direction. If implementation of the baseline PQC roadmap materially lags behind the central assumption, incremental costs attributable to the Act could be higher. This is considered through baseline sensitivity analysis. PO1 adds no PQC-specific measure or incremental PQC cost beyond the dynamic baseline. Under PO2, PM13 is credited only with the incremental costs of a biennial EU preparedness assessment based on information from Member States and Union entities (the first by the end of 2028), coordinated PQC exercises, PQC requirements in public procurement and structured cooperation between the Quantum Strategy Board and the NIS Cooperation Group, including regular exchange, coordination and monitoring of implementation of the existing PQC roadmap. Under PO3, implementation of the existing PQC roadmap becomes binding through time-bound migration requirements. No separate substantive PQC migration, testing or certification costs are attributed to PO3, as these implementation costs are already part of the dynamic baseline. Technical migration costs already attributable to the baseline are not counted again.

Sensitivity analysis tests a stronger baseline, lower and higher participation and cost assumptions, and alternative infrastructure-resource cases. The purpose is to identify whether the relative option ranking depends on optimistic assumptions about the additionality of the Act.

16.6. ANALYTICAL BOUNDARY AND TREATMENT OF THE BASELINE

The calculations are incremental to the dynamic baseline described in the main report. Existing Union and Member State programmes, existing laboratories, existing testing capacity and the ordinary operation of existing facilities are included in PO0. Their historical construction expenditure and ordinary operating expenditure are not attributed to the Quantum Act.

The central case assumes that the Act coordinates and improves access to existing Member State laboratories and adapts existing Chips Act or comparable centres for quantum-related services. It counts only the resources that would be additional to the baseline, including:

- marginal resources for public-facing hub coordination and user services;
- one-off or targeted adaptation of existing centres;
- specialist technical support attributable to the additional quantum functions;
- operation of the governance, monitoring and delivery framework;
- information obligations and adjustment costs created by the option; and
- other incremental administrative and implementation resources.

The central case does not attribute to the Act:

- the original construction cost of existing facilities;
- ordinary laboratory or centre operating expenditure that would occur without the Act;
- the full value of grants, financial instruments, procurement or investment envelopes as societal costs;
- financing volumes as economic benefits;
- user-fee receipts as societal benefits; or
- an assumed monetary value for services provided by hubs or centres where there is insufficient evidence to establish additionality, utilisation and willingness to pay.

A separate full-build scenario is retained only as a stress test. It illustrates the consequences of attributing new-build and broader infrastructure costs to the options but does not represent the central policy design.

View	Content	Treatment in the Impact Assessment
View 1 - Core policy machinery	Administrative, adjustment, coordination, monitoring, implementation and other real-resource costs generated by the policy measures	Included in the central societal cost
View 2a - Gross incremental implementation resources	Marginal hub services and quantum adaptation of existing centres before any residual-value adjustment	Included where additional to PO0
View 2b - Residual-value credit	Remaining value of eligible durable incremental assets at the end of the assessment period	Included only where an eligible durable asset is evidenced
View 2 - Net incremental implementation resources	Gross incremental resources less any eligible residual value	Included in the central societal cost
View 3 - Total societal cost	View 1 plus View 2	Headline cost perimeter
Public-budget impact	EU and Member State expenditure, including transfers and financial commitments where applicable	Reported separately from societal cost
Financing-volume view	Mobilised finance, investment pipeline or demand volumes	Indicator only; not added to welfare benefits
Full-build stress case	Counterfactual construction and broader facility-operation scenario	Sensitivity test only
PO2 programme-resource memorandum	EUR 5.19–6.12 billion indicative Union contribution, corresponding to EUR 12.90–18.08 billion total direct programme resources, with action-specific Member State and industry participation	Reported separately in part D of this Annex; excluded from societal-cost, administrative-burden, OIOO and financing-volume calculations. Broader sector financing needs are reported independently.

Table 4.3. *Cost and resource views used in the workbook*

This separation prevents transfers, investment volumes and real economic-resource costs from being combined in a single total.

16.7. POLICY OPTIONS

The options are alternative appraisal packages constructed along an increasing-intensity ladder. PO2 proposes measures that retain the useful enabling aspects of PO1 while adding targeted legislative and delivery mechanisms. PO3 proposes higher-intensity variants where possible and retains the PO2 architecture where the assessment showed that a higher-intensity implementation would not be feasible. The options remain mutually exclusive for appraisal.

Scenario / policy option	Intervention logic	Main content
PO1 – Voluntary horizontal framework	Non-legislative, ecosystem-wide and market-enabling approach based on voluntary participation.	Voluntary Commission-Member State coordination and structured stakeholder input; non-binding alignment of priorities, scientific cooperation and challenge mapping; voluntary cooperation among facilities, competence centres, investors, buyers and users; and support for skills, standards, supply-chain mapping and international cooperation. It would create no new legal obligations, formal designations, reserved finance or mandatory reporting. Participation by Member States and ecosystem actors would remain voluntary.
PO2 – Enabling Quantum Framework Act	Targeted legislative framework establishing structured EU–Member State governance and delivery arrangements, while relying mainly on existing implementing bodies.	A Regulation would establish common planning and review, governance bodies and a platform gathering structured stakeholder input; formal cooperation between research institutions, quantum facilities and infrastructure to improve access and accelerate technological and industrial development; structured investment and first-buyer support; skills, standardisation and benchmarking coordination; risk-based dependency monitoring; quantum-safe preparedness through a biennial EU preparedness assessment, coordinated exercises and PQC requirements in public procurement, with structured cooperation between the Quantum Strategy Board and the NIS Cooperation Group on implementation and monitoring of the existing PQC roadmap; and coordinated international cooperation. Obligations would fall mainly on the Commission, Member States and designated or Union-supported actors, while participation by other firms and users would generally remain voluntary. The option would not create a new Union agency or an automatic entitlement to funding.
PO3 – High-intensity targeted framework	PO2 architecture combined with stronger, binding variants in a limited number of areas where greater implementation certainty is being tested.	PO3 would retain the full architecture of PO2 and add stronger variants only for PM7, PM10, PM11 and PM13: strategic procurement conditions in predefined categories; dedicated or ring-fenced risk-bearing finance capacity; wider mandatory dependency information and mitigation; and binding implementation of the PQC roadmap. All other measures operate as under PO2.

Table 4.4. *Policy Option architecture*

PO1 contains 15 costed PM families, including the voluntary PM3a challenge-mapping variant; for PM13 it adds no measure beyond the dynamic baseline. PO2 and PO3 also contain all 16. PO3 differs from PO2 only for PM7, PM10, PM11, PM13. Where PO2 and PO3 use the same PM variant, differences in implementation conditions are tested through sensitivity analysis rather than by assuming a different central physical-infrastructure system.

16.8. SELECTION OF POLICY MEASURES

The following table defines the common function of each policy measure. It identifies the baseline gap that justified its inclusion, its principal operating mechanism, the actors

concerned and the main delivery safeguards. The measure names describe policy functions and do not necessarily imply the creation of separate legal entities or funding instruments.

Measure	Baseline gap and reason for selection	Operational content and causal mechanism	Principal addressees, delivery and safeguards
PM1 – Common programming framework	Union and national programmes operate through separate priorities and planning cycles.	Establishes common priorities, an EU programme chapter and structured national quantum chapters, supported by portfolio and gap analysis.	Commission, Member States and implementing bodies. Funding decisions remain with competent programmes and authorities.
PM2 – Quantum Science and Technology (S&T) Excellence Network	European scientific capabilities are strong but dispersed across institutions, programmes and Member States.	Connects leading and emerging capabilities around shared scientific priorities, mobility and access to enabling infrastructures.	Universities, research organisations and RTOs. Distributed structure, open participation and excellence-based selection.
PM3 – Quantum Grand Challenges	Existing calls do not always concentrate sufficient critical mass on shared scientific and engineering bottlenecks.	Uses mission-oriented competitions, milestones and stage gates to concentrate resources and redirect or terminate underperforming activities.	Research organisations, firms and specialised facilities. Open competition, technology neutrality and independent review.
PM4 – Technology and Innovation Hubs	Firms face fragmented access to engineering, prototyping, integration, testing, validation and qualification capabilities.	Designates specialised capabilities and creates transparent cross-border access, accelerating progression from laboratory results to deployable technologies.	Start-ups, SMEs, RTOs and facility operators. Existing capacity first; additional capacity only after demonstrated gap and demand assessment.
PM5 –Strategic Quantum Infrastructures and Strategic Quantum Projects	Cross-border projects must navigate research, infrastructure, finance and procurement instruments separately.	Provides transparent designation and coordinated sequencing of relevant support pathways.	Project promoters, Member States, programmes, facilities and financial institutions. No automatic funding, State-aid approval, procurement preference or regulatory exemption.
PM6 – Competence and Acceleration Centres	Potential users and SMEs lack accessible first-level support for identifying use cases and navigating expertise, finance and infrastructure.	Creates a distributed first-level orientation and referral network connected to Hubs, skills, suppliers, finance and procurement.	SMEs, public authorities and other users. Suitable existing national and regional structures should be reused; Centres do not duplicate Hub engineering functions.
PM7 – Innovation procurement	Public demand is fragmented and successful pilots do not systematically progress to reference deployment or repeat purchasing.	Supports buyer groups, PCP/PPI, functional specifications and reference deployments, creating early revenues and operational evidence.	Contracting authorities, public users and suppliers. Award decisions remain with contracting authorities; conditions require market analysis and proportionality.
PM8 – Standards, benchmarking and assurance	Incomplete terminology, benchmarks, test methods and interoperability references increase due-diligence and deployment costs.	Coordinates measurement methods, benchmarks, interoperability profiles, testing references and maturity-based assurance pathways.	Suppliers, users, metrology bodies and standardisation organisations. Formal standards remain with recognised bodies; PO3 uses the same PM8 variant as PO2.
PM9 – Skills and mobility	Industrial engineering, software, technical, procurement and user-side skills are insufficiently connected to deployment needs.	Links skills intelligence, training, mobility and user-capability actions to infrastructures, projects and procurement.	Member States, education providers, firms, facilities and users. National education competence is preserved;.

PM10 – Quantum Investment Service Desk	Firms face discontinuity between grants, early equity and later-stage industrial finance.	Creates an investment pipeline and thematic window or mandate linking firms and projects to appropriate Union, national and private financing.	Firms, Strategic Projects, financial institutions and private investors. Independent due diligence, additionality and risk-sharing remain applicable.
PM11 – Strategic intelligence and dependency monitoring	No actor has a sufficiently complete Union-level view of critical components, suppliers, substitutability and disruption risks.	Establishes a dashboard, risk-based dependency mapping, early warning and links to diversification and mitigation.	Commission, Member States, supported actors and defined critical value-chain actors. Necessary and proportionate requests, confidentiality, data minimisation and once-only reuse.
PM12 – Quantum Business Platform	Commercial, investment and partnership information is fragmented across countries and technology domains.	Provides voluntary matchmaking among suppliers, users, investors and facilities and improves market visibility.	Firms, users, investors and facilities. Participation remains voluntary and commercial information is separated from regulatory reporting.
PM13 – Quantum-safe preparedness	Implementation readiness under the existing PQC roadmap varies across Member States and critical sectors.	PO1 adds no measure beyond the baseline. PO2 provides for a biennial EU preparedness assessment based on information from Member States and Union entities, coordinated exercises and PQC requirements in public procurement, and establishes structured cooperation between the Quantum Strategy Board and the NIS Cooperation Group for regular exchange, coordination and monitoring of implementation of the existing PQC roadmap; PO3 additionally tests binding roadmap implementation for defined critical actors.	Commission, Member States, ENISA, cybersecurity authorities and defined critical operators. No parallel cybersecurity authority, certification body or incident-reporting regime.
PM14 – Strategic international cooperation	Union and Member State cooperation with third countries is not always coordinated around common priorities, reciprocity and resilience.	Establishes criteria-based coordination for research, standards, skills, market access and trusted supply partnerships.	Commission, Member States and international partners. Applicable programme, trade, security and international-law safeguards remain fully applicable.
PM15 – Quantum Strategy Board	PD1: no durable process jointly reviewing Union and national priorities, gaps and implementation.	Establishes a regular Commission–Member State strategic review cycle, improving visibility, sequencing and coordination.	Commission and Member States. Strategic role only; no transfer of national budgets or programme-management powers.
PM16 – European Quantum Alliance	Stakeholder input from industry, research, users, investors and standards communities remains fragmented.	Provides a structured interface through which ecosystem evidence and implementation feedback inform strategic review.	Industry, start-ups, RTOs, researchers, users and investors. No funding, certification or enforcement powers.

Table 4.5. *Reasoning behind the selection of policy measures*

16.9. POLICY MEASURES VARIANTS PER POLICY OPTION

Below we describe in more detail the different implementations proposed for each Policy Measure (PM), depending on the Policy Option (PO) implemented.

Policy measure	PO1 – Voluntary framework	PO2 – Enabling Quantum Framework	PO3 – High-intensity targeted framework
INTERVENTION AREA 1: Sustaining and further developing Europe's quantum R&I excellence			
PM1: Common programming framework	**PM1a**: Provides a voluntary exchange of information on EU and Member States programmes, and voluntary alignment on common priorities, reinforcing coordination as compared to the dynamic baseline.	**PM1b**. Provides a common EU–Member State framework for developing a shared quantum strategy and linking Union and national programmes through a common programming framework around agreed priorities, while funding and work-programme decisions remain with the competent bodies	**PM1b**. same as PO2.
PM2: Quantum Science and Technology Excellence Network	**PM2a**: Strengthening links across the Quantum Flagship community and European Research Area Networks via a voluntary quantum-focused network of Coordination and Support Actions.	**PM2b**: Statutory establishment of a distributed cooperation network between leading and emerging laboratories, universities, RTOs and infrastructures; creates sustained European scientific and technological critical mass without establishing a central institution. It would foster long-term scientific cooperation and enhance R&I capacity	**PM2b**. same as PO2.
PM3: Quantum Grand Challenges	**PM3a**: Voluntary mapping and alignment on challenges, identified through screening of calls from the EuroHPC JU, EIC Pathfinder/Accelerator Challenges, and other relevant EU, national and regional programmes; no process to redirect or stop unsuccessful pathways.	**PM3b**: Competitively selected, mission-oriented R&I actions bringing together research organisations, firms' industry, start-ups, scale-ups and specialised facilities around ambitious objectives and milestones. They would concentrate resources on selected scientific and technological bottlenecks and unsuccessful pathways would be redirected or stopped thanks to independent review points.	**PM3b**. same as PO2.
INTERVENTION AREA 2: Accelerating Europe's quantum industrialisation, deployment and demand			

PM4: Technology and Innovation Hubs	**PM4a**.Voluntary creation of Specialised Hubs. They would be centred on start-ups and SMEs, bringing together the expertise, services and infrastructure needed for accelerating the technological developments of SMEs, while also providing infrastructure facilities for industrial engineering, prototyping, system integration, testing, validation and qualification of quantum systems and processes.	**PM4b**. Creation of a limited number of Specialised Hubs as described in PM4a. Existing facilities would be used first. Upgrades or new capacity would be supported only where EU-level mapping shows unaddressed important gaps or additional demand for a facility or service.	**PM4b**. same as PO2.
PM5.1 : Strategic Quantum Infrastructures	**PM5.1a**. Supporting, on a voluntary basis, the further development of existing or new large-scale strategic European Pilot infrastructures to demonstrate and validate quantum technologies at European scale before wider deployment. Examples include the European Quantum Communication Infrastructure (EuroQCI) for quantum secure communications, quantum-enhanced medical imaging, a full-scale European quantum computer, the quantum Internet or quantum sensing and gravimetry.	**PM5.1b**. As under PO1, but within a statutory Union framework enabling the continued implementation of existing infrastructures and the selection and development of new pilot quantum infrastructures on Union on the basis of EU added value, cross-border relevance, technological maturity and deployment needs. Funding, procurement and access arrangements would remain under the relevant programmes and competent bodies.	**PM5.1b**. same as PO2.
PM5.2: **Strategic Quantum Projects**	**PM5.2a** Voluntary identification and coordination of major industrial projects of European relevance, such as quantum foundries, or other strategic industrial capabilities.	**PM5.2b** The Commission would designate Strategic Quantum Projects through an open process based on predefined criteria, including Union added value, cross-border relevance, strategic importance and implementation maturity, with input from the Quantum Strategy Board (see PM15). Designation would not automatically confer funding or State aid approval.	**PM5.2b -** same as PO2.
PM6: Competence and Acceleration Centres	**PM6a**. Voluntary distributed first-contact points helping start-ups, SMEs, public authorities and other users identify relevant use cases, and obtain initial technical and business support and referral to Hubs, infrastructures, finance, skills, suppliers and procurement opportunities. They would reduce navigation and adoption barriers without duplicating the specialised engineering role of the Hubs (PM4).	**PM6b**. The centres, as described in PM6a, would be formally created. Each Member State would establish at least one Quantum Competence and Acceleration Centre, individually or jointly with other Member States or partner states.	**PM6b.** same as PO2.

PM7: Innovation procurement	**PM7a**. Voluntary buyer groups, market consultations, supplier–user matchmaking, model procurement documents and technical guidance.	**PM7b**. Coordinated pre-commercial procurement, public procurement of innovative solutions and reference deployments based on common use cases and functional specifications. The measure would strengthen buyer capacity and support progression from experimentation to operational deployment and repeat demand. Procurement decisions would remain with the competent contracting authorities.	**PM7c**. PO2 measures combined with common eligibility or sourcing conditions in predefined strategic procurement categories, only where objectively justified by security of supply or resilience and subject to market-availability tests, proportionate exceptions and applicable Union and international law.
PM8: Standards, benchmarking and assurance	**PM8a**. Support for pre-standardisation, measurement, benchmarking and voluntary technical cooperation.	**PM8b**. Support common terminology, measurement methods, performance benchmarks, interoperability profiles and testing procedures in a structured common pathway. Where technologies and assessment methods are sufficiently mature, voluntary third-party testing or labelling may be used to verify specified performance, interoperability or security claims. Formal standards would remain within the recognised standardisation system.	**PM8b**. Same as PO2.
PM9: Skills and mobility	**PM9a**. Voluntary mapping and exchange on skills needs, training offers, mobility and user-support services.	**PM9b**. Coordinated skills intelligence, training, mobility and reskilling linked to the common programming framework, infrastructures, Hubs, Grand Challenges, Strategic Projects and user capabilities. The measure would focus on demonstrated shortages in engineering, software, systems integration, technical operations and user- and buyer-side expertise, while respecting Member State responsibility for education policy.	**PM9b.** same as PO2.
INTERVENTION AREA 3: Improving Europe's quantum resilience, monitoring and governance mechanisms			
PM10: Quantum Investment Service Desk	**PM10a**. Voluntary investor–company matchmaking, investment-readiness guidance and referrals to existing Union, national and private financing instruments.	**PM10b.** A Commission-coordinated Quantum Investment Service Desk providing investment-readiness advice and facilitating referrals to existing Union, national and private financing opportunities. It may facilitate coordination among financing actors, while individual financing decisions remain with the competent institutions.	**PM10**c. Retains PM10b and adds dedicated quantum investment mandate or capacity within existing or future financial instruments, providing greater risk-bearing and rapid-response support for scale-up and strategic capabilities.

PM11: Strategic intelligence and dependency monitoring	**PM11a**. Voluntary dashboard based on public and voluntarily supplied information.	**PM11b**. Commission-led, risk-based mapping and early warning covering defined critical components, suppliers, concentration, substitutability and disruption risks. Existing information would be used first; supported facilities, designated Strategic Projects and actors in clearly defined critical categories could be required to contribute proportionate information where necessary.	**PM11c**. PM11b mapping combined with targeted mandatory information requests for designated projects, infrastructure operators and actors in predefined critical value-chain categories. Identified risks would be referred to existing finance, procurement, supplier-qualification, diversification and economic-security instruments.
PM12: Quantum Business Platform	**PM12a**. Voluntary creation and participation in a light-touch platform providing company visibility, matchmaking and information on capabilities and needs.	**PM12b**. Voluntary participation in a formally supported platform bringing together quantum firms, users, investors, facilities and public buyers. The platform provides regular matchmaking, market intelligence and visibility of capabilities, needs and partnership opportunities. Commercial information submitted to the platform would remain separate from regulatory reporting and funding eligibility.	**PM12b.** same as PO2.
PM13: Quantum-safe preparedness	**PM13a**. No additional measure beyond the dynamic baseline.	**PM13b**. Structured cooperation on PQC between the Quantum Strategy Board, the NIS Cooperation Group and other relevant existing cybersecurity structures, providing for regular exchange, coordination and monitoring of implementation of the existing PQC roadmap; a biennial EU PQC preparedness assessment, the first by the end of 2028, based on information from Member States and Union entities; coordinated PQC exercises; and PQC requirements in public procurement.	**PM13c**. Make binding the implementation of the existing PQC roadmap through time-bound migration requirements.
PM14: Strategic international cooperation	**PM14a**. Existing partnerships and dialogues would continue, supported by voluntary coordination and information exchange.	**PM14b**. COM, advised by the Quantum Strategy Board (see PM15), would coordinate trusted and reciprocal cooperation with third countries covering research, standards, skills, reciprocal infrastructure and market access, use cases and supply diversification. It would coordinate EU and Member State approaches, help build critical mass and resilient supply relationships while distinguishing open research from sensitive deployment and protecting Union interests.	**PM14b.** same as PO2.

PM15: Quantum Strategy Board	**PM15a**: Advisory group bringing together the Commission, Member States and relevant national implementing bodies. It will strengthen the informal EU-MS coordination of the dynamic baseline, while exchange of information and alignment would remain purely voluntary.	**PM15b**: High-level Commission–Member State body for developing a shared strategy, agreeing common priorities, reviewing implementation and identifying investment, infrastructure and capability gaps and potential synergies. It is needed because no existing body reviews the combined Union and national quantum portfolio.	**PM15b**. same as PO2.
PM16: European Quantum Alliance	**PM16a**: Voluntary structured stakeholder platform bringing together industry, start-ups, research organisations, RTOs, users, investors and standards communities. It would provide evidence and implementation feedback, enabling structured stakeholder input as compared to the informal research and industry networks of the dynamic baseline.	**PM16b same as PM16a**, with the Alliance being formally established and linked to the Quantum Strategy Board for the functions detailed in PM16a.	**PM16b**. same as PO2

Table 4.6. *Policy Measures per Policy Option*

Together, the measures address the full intervention chain from strategic prioritisation and scientific excellence to industrialisation, finance, deployment, trusted uptake and resilience. Several measures respond to more than one driver because the identified market, coordination and information failures are mutually reinforcing.

17. PART B - COST MODEL

17.0. COST TYPOLOGY

Costs are classified in accordance with the Better Regulation Toolbox.

Cost category	Examples in the Quantum Act
One-off administrative costs	Initial templates, national chapters, dashboard design, designation procedures and establishment of structured PQC coordination arrangements between the Quantum Strategy Board and the NIS Cooperation Group.
Recurrent administrative costs	Board participation, periodic updates, monitoring, reporting, targeted information responses and information validation, national information for the PQC preparedness assessment, evidence of compliance with PQC requirements in public procurement and its verification, and the information that firms provide to take part in regulatory sandboxes, the business platform or investment support (applications for investment support are not offset under One-In, One-Out)
One-off adjustment costs	Adapting facility procedures, data systems or internal processes
Recurrent adjustment costs	Access management, assurance activities, updating migration plans and maintaining cryptographic-asset inventories (PM13c, PO3 only).
Enforcement and implementation costs	Review of obligations, Strategic Project monitoring, follow-up to information requests and Member State participation in coordinated PQC exercises; implementation of the act by the Commission (administration, platform build and operation), implementing bodies, Commission-financed experts and Hub and Centre operators; effort of Member State authorities in measures that the act enables but does not require (joint innovation procurement, PQC cooperation)
Participation without a legal requirement (not a compliance cost)	Time that firms choose to spend in the new structures without any legal requirement (Alliance input, standards and benchmarking work, platform input and matchmaking, PQC expert time). Counted in the total societal cost; not a compliance cost under Tool #56 and outside One-In, One-Out.
Substantive programme expenditure	Grants, procurement, infrastructure support and financial allocations; treated separately from administrative costs
Regulatory fees or charges	None assumed unless expressly introduced in the final legal design

Table 4.7. *Cost categories*

Costs are allocated to:

- Commission and Union services;
- Member State authorities;
- implementing bodies, Joint Undertakings and agencies;
- businesses and infrastructure operators; and
- other affected actors where relevant.

Information that firms provide as a condition of Union funding, Strategic Project designation, supported procurement or PQC requirements in public procurement, in reply to a targeted request, or to take part in a regulatory sandbox, the business platform or investment support is costed as an administrative cost. Documentation for investment support (PM10) is an application for financial support and is therefore not offset under One-In, One-Out (Tool #58, Box 4). The effort of Member State authorities in measures that the act enables but does not require (joint innovation procurement, PQC cooperation) is an implementation cost, which Tool #56 counts as an enforcement cost. Time that firms choose

to spend in the new structures without any legal requirement is not a compliance cost; it is included in the total societal cost and shown separately (Table 4.21).

17.1. CALCULATION METHODOLOGY

Each individual model item identifies:

- the responsible or affected actor;
- the cost or benefit category;
- whether the item is one-off or recurrent;
- the starting year and duration;
- the affected population;
- the frequency of the activity;
- the time requirement;
- the applicable labour-cost rate;
- any non-labour unit cost;
- the relevant Policy Measure variant;
- the low, central and high assumptions; and
- the source and evidential strength of the assumption.

Component	Calculation approach
One-off labour cost	Number of affected actors × person-days per actor × labour-cost rate
Recurrent labour cost	Number of affected actors × frequency per year × person-days per event × labour-cost rate
Non-labour resource cost	Number of actors or activities × applicable unit cost
Administrative burden on businesses	Business population × frequency × time per information obligation × labour-cost rate, plus necessary external costs
Commission resources	Commission person-days divided by 225 to obtain FTE, plus relevant non-staff resources
Member State resources	Aggregate person-days across Member States divided by 225; per-Member-State figures divide the aggregate by 27
Hub-service resources	Number of hubs × marginal annual service cost per hub × years of service
Centre adaptation	Number of Centres × incremental quantum-adaptation cost per Centre, phased over the implementation period
Cost savings	Time or resource saving per beneficiary × beneficiary population × frequency, subject to applicable caps
Net modelled cost	Total societal cost minus modelled monetised cost savings
Partial benefit-cost ratio	Modelled monetised cost savings divided by total societal cost
Public-budget impact	Relevant administrative resources plus programme expenditure and transfers, net of any fee revenue
Financing volume	Potential financing or investment activity; memorandum indicator only

Table 4.8. *Principal calculation methods*

All annual values are discounted at 3%. Low and high values are used in deterministic sensitivity analysis. Where the evidence is insufficient to support a central value, the possible impact is either excluded or shown as a separate scenario.

17.2. STANDARD COST MODEL

The model is a bottom-up Standard Cost Model covering 16 PM families, 35 live Policy Measure variant sheets (15 variants in PO1, 16 in PO2 and in PO3). Each item identifies the actor, activity, cost or saving category, one-off or recurrent character, start year, affected population, frequency, person-days, labour rate, non-labour unit cost, PM variant, low/central/high assumptions, source and evidential strength.

Annual costs are calculated separately for one-off labour, recurrent labour and non-labour resources:

One-off labour cost in year t = number of affected actors × person-days per actor × applicable person-day rate.

Recurrent labour cost in year t = number of affected actors × annual frequency × person-days per event × applicable person-day rate.

Non-labour resource cost in year t = quantity of resources or activities × applicable unit cost.

Annual costs and savings are converted to present values in the 2028 base year:

PV(X) = Σ from t = 2028 to 2037 of X_t / (1 + r)^(t − 2028), with r = 0.03 in the central case.

The model reports two equivalent net concepts and keeps their signs explicit:

- Signed monetised NPV = present value of modelled savings minus present value of total societal cost.
- Positive net modelled cost = present value of total societal cost minus present value of modelled savings.
- Partial benefit-cost ratio = present value of modelled monetised savings divided by present value of total societal cost.

The partial ratio is not a complete welfare benefit-cost ratio because most strategic and capability benefits are not monetised.

17.3. CALCULATION COMMON PARAMETERS

This section sets out the equations used to calculate annual costs, present values, net present values, staffing requirements and the equivalent annual administrative burden. All monetary values are expressed in real 2024 prices unless stated otherwise. Factors that are not applicable to a specific cost item are set equal to one.

17.3.1. Annual cost calculation

For a labour-based cost item ***i*** in year ***t***, the central annual cost is calculated as:

$$C_{i,t}^{lab} = d_i \times n_{i,t} \times f_{i,t} \times p_{i,t} \times a_{i,t} \times R_t$$

where:

d_i – person-days required per occurrence or entity;

$N_{i,t}$ – number of relevant entities, cases or occurrences in year t;

$f_{i,t}$ – frequency per year;

$p_{i,t}$ – participation or coverage rate;

$a_{i,t}$ – share attributable to the policy option rather than the baseline; and

R_i – relevant fully loaded person-day rate.

For a non-labour resource item, the annual cost is calculated as:

$$C_{i,t}^{non-lab} = u_i \times q_{i,t} \times f_{i,t} \times a_{i,t}$$

where u_i is the unit cost and $q_{i,t}$ is the relevant quantity in year t. Total annual cost is the sum of all labour and non-labour cost items:

$$C_t = \sum_{i=1}^{I} C_{i,t}$$

One-off costs are entered only in the year in which they arise. Recurrent costs are entered from the applicable start year to the end of the assessment period, unless the measure has a specified shorter duration.

17.3.2. Present-value calculation

For any annual stream X_t, the present value in the 2028 base year is calculated as:

$$PV(X) = \sum_{2028}^{2037} \frac{X_t}{(1+r)^{t-2028}}$$

where r is the real discount rate. The central calculation uses r = 3%. The same formula is applied separately to the annual benefit stream B_t and the annual cost stream C_t.

$$NPV = PV(B) - PV(C)$$

A positive NPV indicates that monetised benefits exceed monetised costs. For tables that report the positive value of the net modelled cost rather than signed NPV, the following identity is used:

$$NMC = PV(C) - PV(B) = -NPV$$

where NMC denotes the net modelled cost. The benefit-cost ratio is calculated as:

$$BCR = \frac{PV(B)}{PV(C)}$$

The benefit-cost ratio is reported only where PV(C) is greater than zero and the benefit and cost estimates use the same analytical perimeter.

17.3.3. Conversion of person-days into full-time equivalents

Annual person-days are converted into full-time equivalents using 225 working days per FTE:

$$FTE_t = \frac{D_t}{225}$$

where D_t is the total number of person-days required in year t. Peak FTE is the highest annual FTE requirement during the assessment period:

$$FTE_{peak} = max_{t \in \{2028,\ldots,2037\}} FTE_t$$

These estimates indicate the workload implied by the modelled activities and do not constitute an establishment-plan decision.

17.3.4. Equivalent annual administrative burden for One-In, One-Out reporting

The equivalent annual administrative burden is obtained by converting the present value of the administrative-burden stream into a constant annual amount over 2028-2037 using the same discounting convention:

$$EAC_{AB} = \frac{PV(AB)}{\sum_{2028}^{2037}(1+r)^{-(t-2028)}}$$

where PV(AB) is the present value of the relevant administrative-burden stream. With r = 3% and ten annual observations from 2028 to 2037 inclusive, the denominator is 8.78611:

$$EAC_{AB} = \frac{PV(AB)}{8.78611}$$

This produces an equivalent constant annual amount that has the same 2028 present value as the original burden stream. The classification of costs as OIOO-relevant remains separate from the mathematical annualization.

17.4. COMMON VALUATION ASSUMPTIONS

Parameter	Central value	Treatment
Price year	2024	All monetary values expressed in real 2024 prices, except the Commission labour-cost anchor, which keeps its 2022 comparator value (see Table 4.12).
Assessment period	2028–2037	One-off and recurrent flows assigned to the relevant year; present-value base year 2028.
Discount rate	3% real	Sensitivity at 1.5% and 4.5%.
Hours per person-day	8	Standard Cost Model convention.
Working days per FTE	225	Applied consistently to Commission, Member State and implementing-body staffing estimates.
Member States	27	All 27 for obligations under PO2 and PO3; for voluntary activities, the number of participating Member States recorded for each activity
Coordination-adoption share	64%	Share of the addressed population adopting a structured coordination output; Chips Act 2.0 IA survey used as a proxy. Sensitivity 53-75%.
Voluntary-participation share	55%	Share of the eligible population taking up a voluntary tool; expert judgement, no observed quantum rate. Sensitivity 40-75%. Drives 11 model items.
Baseline fragmentation pool	EUR 110m/year	Upper bound on monetised coordination/duplication savings; sensitivity EUR 66–176m/year. Non-binding ceiling on coordination and duplication savings (sensitivity EUR 66-176m/year); modelled savings stay far below it, so it is not evidence that they occur.

Table 4.9. *Common valuation assumptions*

At 3%, the discounted annuity factor for recurrent annual administrative burdens over 2028–2037 is approximately 8.78611. The equivalent annual OIOO burden is the NPV of the administrative burden divided by this factor.

Assumption	Definition and denominator	Low / central / high	Source	Where used and sensitivity
Voluntary-participation share	Share of the eligible beneficiaries taking up a voluntary tool; denominator = the item's population (e.g. 40 firms seeking finance a year; 115 programme units)	40% / 55% / 75%	Benchmarks: a costly joint project drew 14 of 27 Member States (52%; IPCEI on microelectronics and communication technologies, 2023); a low-cost pledge drew 11 at signature (41%) and all 27 by mid-2025 (European Declaration on Quantum Technologies). Central value set near the costly-commitment benchmark, as the savings need effort from participants; the range spans both; no observed take-up rate specifically for quantum support tools.	Savings only (Table 4.16): nine PO1 lines (EUR 3.99m of 5.39m); PM10b under PO2 (0.44m of 13.59m); PM10c under PO3 (0.69m). Also inside the overlap-adjusted factor of PM6b navigation (2.48m, PO2 and PO3) and of two PO1 lines, which the participation cases do not vary. Participation cases: Table 4.27

Coordination-adoption share	Share of the addressed population adopting a structured coordination output; for PM1a it is applied to all 27 Member States as a participation share	53% / 64% / 75%	Chips Act 2.0 impact assessment, stakeholder survey (Synopsis Report, Figure 11): 75% of authorities, 53% of research and technology organisations; central value = mid-point, range = the two values. Stated intentions in the semiconductor ecosystem; transferability to quantum coordination not demonstrated.	PO2: nine savings lines, EUR 9.05m of 13.59m (Table 4.16); PO3: nine lines, EUR 9.25m of 14.04m; PO1: PM1a Member State participation (27 × 0.64), a cost of EUR 0.35m. Participation cases: Table 4.27
Member State participation	Number of Member States performing an activity. Obligations (PO2, PO3): all 27. Opt-in and PO1 activities: those expected to take part (PM7 buyer group 5; PM7b 8 procurements a year; PM1a exchanges 27 × 0.64, about 17). Other PO1 Member State lines (Board, mapping, monitoring, skills, international coordination) assume all 27, an upper bound for a voluntary option.	Obligations: 27; PM7 buyer group: 4 / 5 / 6; PM1a: 27 × 53% / 64% / 75%	Tool #58 (full compliance with obligations); participation benchmarks as for the voluntary-participation share.	All Member State cost lines; the all-27 assumption carries EUR 11.40m of the EUR 14.51m of PO1 Member State costs
Quantum-safe preparedness (PM13b; retained under PO3)	Biennial EU preparedness assessment with information from the 27 Member States; coordinated exercises every two years; PQC requirements in public procurement, applied in 60% of 270 relevant procedures a year; Commission work on the function	Per cycle and Member State: information 30 days, exercises 6 days; per procedure: 3 bidder-days, 2 authority-days; Commission 4.0 FTE. Low / high: 0.5 / 1.5 times (Commission work 0.67 / 1.5 times)	Commission estimate by task (Table 4.15); Member State, bidder and authority days set by analogy with other information obligations in the model; no observed data on PQC procurement.	PO2: PM13b EUR 8.72m NPV, of which Commission 4.57m, Member States 2.75m and businesses 1.40m (1.23m within One-In, One-Out); PO3: retained in PM13c.
PM13c covered entities	Critical public authorities (60%) and operators (40%) subject to binding PQC migration duties	250 / 450 / 800	Scoping assumption; depends on the scope of the binding duties; Low	PO3 only: PO3 cost EUR 141.6m / 163.6m / 202.1m NPV

PM13c reuse of existing plans	Share of one-off migration-plan effort already covered by existing inventories and plans (baseline deduction on one-off rows only)	5% / 25% / 44%	Expert assumption.	PO3 only: EUR -1.8m / +1.9m NPV
Hubs costed (Central case)	Existing hubs providing marginal public-facing services from 2030	5 (ambition up to 8)	Illustrative costing assumption (Commission choice)	8 hubs: +EUR 10.2m NPV
Marginal service per hub-year	Additional public-facing service beyond ordinary operation	EUR 0.25m / 0.50m / 1.00m	EuroCC competence centres: EUR 57m over two years for 33 centres, half EU-funded (about EUR 0.86m per centre-year); EDIH: EU funding of EUR 0.5–1.0m per hub-year. Central value = EU share of an EDIH-type service layer at a facility whose ordinary operation stays in the baseline.	PO2, PO3: 5 hubs × EUR 0.50m a year, 2030–2037 = EUR 17.04m NPV. RC-L / RC-H: Table 4.26
Centres costed and adaptation per Centre	Existing or suitable Centres adapted once, 2028-2030	15 (ambition 27); EUR 0.10m / 0.30m / 0.75m	Set against EDIH grant levels (EU funding of EUR 0.5–1.0m per hub-year) for a one-off adaptation of an existing facility.	PO2, PO3: 15 × EUR 0.30m, a third a year in 2028–2030 = EUR 4.37m NPV. 27 Centres: +EUR 3.5m NPV
Specialist top-up per Centre-year	Additional specialist support from 2030, high case only	0 / 0 / EUR 0.20m	Policy choice	Included in RC-H only
Commission day rate	EUR 130,000 per FTE-year incl. overheads / 225 productive days (2022 comparator, not re-based)	EUR 533 / 578 / 636	Comparable IA (SWD(2022) 286); Medium; verified salary-scale factor 1.1014 applied to the high case only	Price-year case: PO2 +EUR 3.00m NPV
Member State day rate	Fully loaded national official	EUR 320 / 380 / 440	Standard Cost Model of the PPMI/d-fine support study.	PO2 EUR 101.1m / r8m NPV
Commission staffing by function	Commission staff needed for each function (e.g. dependency monitoring, EU programming chapter, quantum-safe preparedness, Quantum Strategy Board secretariat, investment pipeline, supervision of Strategic Projects)	PO2: 26.0 FTE on average (22.3 in 2028, 26.2 to 26.7 a year from 2029); uncertainty in the probabilistic analysis (Table 4.30)	Standard Cost Model of the support study; comparable functions in other impact assessments and bodies (Chips Act 2.0, Critical Raw Materials Board); Commission estimates where neither applies.	Commission staff cost.
Fragmentation pool (ceiling)	EU and national public quantum funding x recoverable duplication share	EUR 66m / 110m / 176m a year	COM(2025) 363 funding base x 5% diagnostic share.	Non-binding; stronger-baseline case changes savings instead

Table 4.10. *Register of material assumptions*

17.5. CENTRAL IMPLEMENTATION AND PROGRAMME ASSUMPTIONS

The central case assumes reuse of existing infrastructures. The numbers of hubs and Centres are costing assumptions rather than predetermined policy commitments. The actual facilities would be determined through capacity and gap assessments, transparent selection procedures and future implementation decisions.

Parameter	Low	Central	High	Period and analytical treatment
Existing hubs used for costing	5	5	5	Illustrative network size; no new construction in the central case
Marginal public-facing service per hub	EUR 0.25m/year	EUR 0.50m/year	EUR 1.00m/year	2030–2037; counted as a real societal resource
Total marginal hub service	EUR 1.25m/year	EUR 2.50m/year	EUR 5.00m/year	Five hubs; ordinary facility operation remains in the baseline
Existing or suitable Centres used for costing	15	15	15	Illustrative number; not a commitment to designate particular Centres
Quantum adaptation per Centre	EUR 0.10m	EUR 0.30m	EUR 0.75m	Phased over 2028–2030; counted as a real societal resource
Total Centre adaptation	EUR 1.50m	EUR 4.50m	EUR 11.25m	Nominal amount before discounting
Specialist top-up per Centre	EUR 0	EUR 0	EUR 0.20m/year	2030-2037; high case (RC-H) only; together with the higher unit costs it raises the module to EUR 65.45m NPV
PO2 substantive programme-resource envelope		EUR 5.19–6.12bn EU		2028–2034 planning range; detailed allocation in part D of this Annex; memorandum only and excluded from the Standard Cost Model
Excellence Network coordination envelope	EUR 0.50m/year	EUR 1.00m/year	EUR 1.50m/year	2029–2037; coordination resources
Financing mobilisation target	EUR 1bn	EUR 2bn	EUR 3bn	Financing-volume indicator
Illustrative co-financing leverage	1.5×	2.5×	4.0×	Indicator, not a monetised benefit
Fragmentation/duplication pool	EUR 66m/year	EUR 110m/year	EUR 176m/year	Used to cap coordination savings
PQC migration expenditure	EUR 3bn	EUR 6.5bn	EUR 10bn	Baseline context for 2025–2035; not attributed to the Quantum Act

Table 4.11. *Principal implementation and programme parameters*

These are model assumptions rather than observed population data. The low and high values show the range tested.

Under the central assumptions, marginal services through five existing hubs (EUR 0.50 million per hub-year, 2030-2037) have an NPV of EUR 17.04 million and the one-off adaptation of fifteen Centre (EUR 0.30 million each, phased equally over 2028-2030) has an NPV of EUR 4.37 million. Their combined central NPV is therefore EUR 21.41 million under PO2 and PO3. The high case raises the unit costs to EUR 1.00 million per hub-year and EUR 0.75 million per Centre and adds the specialist top-up, for EUR 65.45 million in total: it changes the scope and timing of the support, not only two unit costs. The rollout beyond five hubs and fifteen Centres is not costed (see Part A).

17.6. LABOUR-COST PROXIES

Actor	Central rate	Basis
Commission and Union services	EUR 577.78/person-day	EUR 130,000 per FTE-year including overheads, from the European Media Freedom Act IA

		(SWD(2022) 286), divided by 225 productive days. Used at its 2022 value; the verified 2022-2024 salary-scale factor (1.1014) gives EUR 636.34 which is used in the high case.
Member State authorities	EUR 380/person-day	Fully loaded national official; rate from the Standard Cost Model of the PPMI/d-fine support study; sensitivity EUR 320-440.
Implementing bodies and operators	EUR 261.60/person-day	Applied to the programme, facility and delivery functions of implementing bodies and operators, including calls and network coordination or oversight under PM2b, PM4b and PM6b. Rate from the Standard Cost Model of the PPMI/d-fine support study
Businesses and private actors	EUR 324/person-day	Applied to business information and participation activities. Rate from the Standard Cost Model of the PPMI/d-fine support study.
External experts	EUR 450/person-day	Applied where external technical expertise is purchased. Rate from the Standard Cost Model of the PPMI/d-fine support study.

Table 4.12. *Labour-cost proxies*

17.7. STAFF-TIME AND FTE ASSUMPTIONS

Annual FTE = annual person-days / 225. The estimates indicate the resources implied by the modelled activities. They do not constitute decisions on the Commission establishment plan or national staffing allocations and remain sensitive to the final allocation of responsibilities and the extent to which existing teams can absorb tasks.

The total number of FTEs were derived from the estimated effort required in person-days for the performance of the tasks of each PM.

Resource indicator	PO1	PO2	PO3
Commission peak FTE	17.0	26.7	31.7
Commission average FTE, 2028–2037	16.8	26.0	30.8
Member State peak FTE, EU aggregate	19.9	42.3	117.7
Member State average FTE, EU aggregate	19.4	41.2	86.5
Member State peak FTE per Member State	0.74	1.57	4.36
Member State average FTE per Member State	0.72	1.52	3.20

Table 4.13. *Indicative administrative resource requirements*

The Commission FTEs needs are broken down by each Policy Measure and Policy Option are as follows:

PM	Measure	PO1		PO2		PO3	
		Avg	Peak	Avg	Peak	Avg	Peak
PM1	Common programming framework	2.76	3.56	4.08	4.80	4.08	4.80
PM2	Quantum S&T Excellence Network	1.24	1.33	0.03	0.32	0.03	0.32
PM3	Quantum Grand Challenges	0.36	0.36	0.53	0.59	0.53	0.59
PM4	Technology and Innovation Hubs	0.64	0.67	0.00	0.00	0.00	0.00
PM5	Strategic Quantum Projects	0.97	1.00	2.37	2.50	2.37	2.50
PM6	Competence and Acceleration Centres	0.65	0.67	1.00	1.00	1.00	1.00
PM7	Innovation procurement	0.30	0.33	0.64	0.71	1.41	1.64
PM8	Standards, benchmarking and assurance	0.63	0.64	0.91	0.96	0.91	0.96
PM9	Skills and mobility	1.20	1.40	1.00	1.00	1.00	1.00
PM10	Quantum Investment Service Desk	1.40	1.40	2.89	2.90	5.44	6.80

PM11	Strategic intelligence and dependency monitoring	2.53	2.67	4.26	4.53	5.28	5.73
PM12	Quantum Business Platform	0.10	0.11	0.19	0.21	0.19	0.21
PM13	Quantum-safe preparedness	0.00	0.00	4.00	4.00	4.41	4.53
PM14	Strategic international cooperation	0.60	0.60	1.00	1.00	1.00	1.00
PM15	Quantum Strategy Board	1.39	1.87	2.92	3.92	2.92	3.92
PM16	European Quantum Alliance	2.05	2.53	0.18	0.18	0.18	0.18
Total		**16.8**	**17.0**	**26.0**	**26.7**	**30.8**	**31.7**

Table 4.14. *European Commission estimated effort in FTEs breakdown per PM*

Table 4.14 converts the Commission person-days of the cost items in Table 4.15 into FTE (225 days per FTE). For PO2 the requirement is 22.3 FTE in 2028, 26.2 in 2029 and 26.4 to 26.7 a year from 2030. Average FTE is the mean of the ten annual values 2028-2037; a measure's peak is its own highest year, and the package peak in the Total row is the highest annual package total, which is lower than the sum of measure peaks (PO2: 26.7 against 28.6). The estimates are task-equivalent workload, not establishment-plan posts.

Table 4.15 sets out the Commission functions behind the PO2 staffing estimate in Table 4.14: what the Commission does and what others deliver, the scale of the activity, the basis for the estimate, and the start-up and continuing requirement. Repeatable work is calculated from volumes and days per case; continuing secretariat, coordination and supervision work rests on the Standard Cost Model of the support study, on comparable functions in other impact assessments and bodies or, where neither applies, on Commission estimates. The figures are task-equivalent workload, not establishment-plan posts; their uncertainty is covered by the probabilistic analysis (Table 4.30).

Function	**Commission role and scope**	**Scale**	**Basis for the estimate**	**FTE 2028**	**FTE 2029–2037 (average)**	**FTE 2028–2037 (total average, Table 4.14)**
Strategic intelligence and dependency monitoring (PM11b)	Sector taxonomy and registry (2028); annual dependency dashboard and early warning; critical-components list; verification of the reports requested from firms; scenario exercises. Member States supply national data.	27 national data returns; 45 reporting firms; one dashboard release a year	Standard Cost Model of the support study; critical-components list on the model of the Critical Raw Materials Act; verification and scenario exercises: Commission estimates	2.00	4.51	4.26
Common programming framework (PM1b)	National-chapter template (2028); annual EU chapter and programme-alignment report; assessment of non-aligned national chapters (comply-or-explain).	27 national chapters; 2 Joint Undertakings	Template: Standard Cost Model of the support study; EU chapter and alignment report scaled from the Chips Act 2.0 impact assessment; comply-or-explain: Commission estimate	4.80	4.00	4.08

Quantum-safe preparedness (PM13b)	Biennial PQC preparedness assessment (the first by the end of 2028) on the basis of information from Member States and Union entities; coordinated exercises; guidance and follow-up on PQC requirements in public procurement; cryptanalysis follow-up; coordination with the NIS Cooperation Group and other cybersecurity structures. Member States supply the information and take part in the exercises; contracting authorities apply the procurement requirements.	27 Member States; one assessment and one exercise every two years	Commission estimate by task: assessment cycle 300 days, exercises 160, procurement 140, coordination 120 and implementation support 180 a year	4.00	4.00	4.00
Quantum Strategy Board (PM15b)	Chair and secretariat: set-up, governance calendar, plenary and sub-group papers, written procedures, records and transparency, coordination of Member State positions, monitoring, reporting and follow-up. Member States and the Joint Undertakings bear their own participation.	27 Member States; 4 plenaries and 5 sub-groups a year	Secretariat of 2 FTE, as for comparable boards (Critical Raw Materials Board); meetings under the horizontal rules on Commission expert groups; sub-groups 5 × 30 days a year (Commission share)	3.92	2.81	2.92
Quantum Investment Service Desk (PM10b)	Investment pipeline: intake, eligibility and assessment, decision support, monitoring of supported cases and reporting; due diligence; opinions on strategic-capability transactions. Investment decisions remain with the financial institutions concerned.	About 12 investment cases and 1 strategic-capability transaction a year	Due diligence: 15 days per case (Standard Cost Model of the support study); pipeline coordination: 2 FTE, Commission estimate	2.80	2.90	2.89
Strategic Quantum Projects (PM5b)	Designation framework (2028); assessment of applications, designation decisions, monitoring of designated projects, withdrawal and escalation.	About 9 applications a year in 2029–2033; up to 15 designated projects	Framework: Standard Cost Model of the support study; designation and supervision sized on the caseload (2.5 FTE from 2029)	1.20	2.50	2.37
Strategic international cooperation (PM14b)	Identification and assessment of partners, preparation of cooperation frameworks, follow-up and reporting.	4 partner assessments a year	Partner assessments 4 × 25 days a year and framework conclusions: Commission estimates	1.00	1.00	1.00

Oversight of the Centre network (PM6b)	Residual oversight of the network run by an implementing body: framework approval, work-programme and performance review, hub supervision, sandbox oversight, escalation, reporting and evaluation.	15 Centres; 5 hubs; 3 sandbox cycles a year	Commission estimate of the oversight retained when the network is run by an implementing body	1.00	1.00	1.00
Skills and mobility (PM9b)	Coordination of skills, mobility, training and user-capability actions; annual user-capability report.	Annual cycle of Union skills and mobility actions	Commission estimate, by reference to the coordination of the European Digital Innovation Hubs and EuroCC	1.00	1.00	1.00
Other measures (PM2b, PM3b, PM7b, PM8b, PM12b, PM16b)	Grand Challenge gate reviews and benchmarks; procurement templates and support to buyer groups; standardisation requests and benchmarking; platform matchmaking; Alliance linkage; review of the Excellence Network's legal form.	3 Grand Challenges; 8 supported procurements, 2 standardisation requests and 4 matchmaking events a year	Repeatable work: volume × days per case (40 per gate review, 20 per supported procurement, 80 per standardisation request, 30 per matchmaking event; where work is shared, the Commission share only); other work: Commission estimates	0.60	2.68	2.48
Total PO2				**22.32**	**26.40**	**26.00**

Table 4.15. *Commission staffing by function, PO2 (FTE)*

17.8. TREATMENT OF BENEFITS

Benefits are quantified or monetised only where the causal mechanism is sufficiently clear and the underlying assumption can be tested, otherwise, the benefits are treated qualitatively rather than quantitatively.

17.9. DIRECT ADMINISTRATIVE SAVINGS

Direct savings may arise from:

- common templates;
- reduced duplicate reporting;
- reuse of existing programme data;
- a single-entry point for infrastructure access;
- common specifications; and
- reduced search, application or negotiation time.

Savings are calculated using the same staff-time and labour-cost methodology as administrative costs.

Each monetised saving line applies the structure: annual saving = beneficiary population x days saved per unit x take-up or participation share x beneficiary day rate, from the start year to 2037, discounted to 2028. Take-up and additionality are embedded once in the registered share. Worked example (PM10b, financing search): 40 firms x 55% x 8 days x EUR 324 = EUR 57,024 a year from 2029 to 2037, or EUR 443,995 NPV. Table 4.16 sets out every monetised saving line of the three options.

17.10. QUANTIFIED NON-MONETARY OUTCOMES

Where monetisation would require speculative assumptions, the assessment uses physical or financial outcome indicators.

Channel	Calculation	Illustrative result
Infrastructure access	40–120 projects × one to two months earlier access or qualification	40–240 project-months brought forward annually
Scale-up finance	EUR 100m Union risk-bearing finance × 1.5–3.5 private leverage	EUR 150–350m private co-investment
Innovation procurement	EUR 100m procurement × empirical supplier-revenue and investment coefficients	EUR 25–50m persistent supplier revenue and EUR 10–20m additional private investment
Supply-chain resilience	191 observed delay days × 10–30% avoidable share	19–57 days saved per comparable affected project

Table 4.16. *Principal quantified benefit scenarios*

These scenarios use different units and must not be added together.

The infrastructure and resilience scenarios are based partly on observed quantum-sector evidence. The finance and procurement scenarios are informed by comparable instruments and cross-sector studies and are therefore assigned lower confidence regarding their magnitude.

Table 4.17 lists every monetised saving line of the three options. Annual saving = population × days saved per unit × take-up share (× overlap adjustment) × beneficiary day rate, from the start year to 2037, discounted to 2028. The take-up shares are the coordination-adoption share (0.64), the voluntary-participation share (0.55), sandbox output adoption (0.40), platform participation (0.50 under PO1, 0.70 under PO2 and PO3) and template and benchmark uptake (0.80). The overlap adjustment (0.65 or 0.85) removes the part of an effect already counted under another measure.

Measure	Saving line	Beneficiary	Options	Population × days saved × take-up (× overlap) × day rate	Years	Annual saving (EUR)	NPV (EUR million)
PM1a	Reduced duplication (voluntary uptake)	Member States	PO1	115 × 8 days × 0.55 × EUR 380	2029–2037	192,280	1.50
PM1b	Reduced duplication in programme planning	Member States	PO2, PO3	115 × 16 days × 0.64 × EUR 380	2029–2037	447,488	3.48
PM2a	Avoided duplication	Implementing bodies	PO1	25 × 5 days × 0.55 × EUR 261.60	2030–2037	17,985	0.12
PM2b	Avoided duplication of frontier coordination	Implementing bodies	PO2, PO3	30 × 8 days × 0.64 × EUR 261.60	2030–2037	40,182	0.27
PM4a	Qualification access (voluntary)	Businesses	PO1	80 × 4 days × 0.55 × EUR 324	2030–2037	57,024	0.39
PM4b	Avoided duplicated qualification and testing	Businesses	PO2, PO3	120 × 10 days × 0.64 × EUR 324	2030–2037	248,832	1.70
PM5a	Visibility and coordination	Businesses	PO1	15 × 4 days × 0.55 × EUR 324	2030–2037	10,692	0.07

Measure	Saving line	Beneficiary	Options	Population × days saved × take-up (× overlap) × day rate	Years	Annual saving (EUR)	NPV (EUR million)
PM5b	Coordination and priority access, wave 1	Businesses	PO2, PO3	6 × 12 days × 0.64 × EUR 324	2030–2037	14,930	0.10
PM5b	Coordination and priority access, wave 2	Businesses	PO2, PO3	9 × 12 days × 0.64 × EUR 324	2032–2037	22,395	0.11
PM6a	Navigation (overlap-adjusted ×0.85)	Businesses	PO1	250 × 3 days × 0.55 × 0.85 × EUR 324	2030–2037	113,602	0.77
PM6b	Navigation and first access (overlap-adjusted ×0.85)	Businesses	PO2, PO3	400 × 6 days × 0.55 × 0.85 × EUR 324	2030–2037	363,528	2.48
PM6b	Sandbox avoided rework	Businesses	PO2, PO3	36 × 8 days × 0.40 × EUR 324	2031–2037	37,325	0.22
PM7a	Templates	Member States	PO1	5 × 4 days × 0.55 × EUR 380	2030–2037	4,180	0.03
PM7b	Template and evaluation savings	Member States	PO2	8 × 5 days × 0.64 × EUR 380	2030–2037	9,728	0.07
PM7c	Templates	Member States	PO3	8 × 5 days × 0.64 × EUR 380	2030–2037	9,728	0.07
PM8a	Qualification (guidance uptake)	Businesses	PO1	100 × 1 days × 0.80 × 0.85 × EUR 324	2030–2037	22,032	0.15
PM8b	Avoided qualification cost	Businesses	PO2, PO3	150 × 3 days × 0.80 × 0.85 × EUR 324	2030–2037	99,144	0.68
PM10a	Financing search	Businesses	PO1	30 × 5 days × 0.55 × EUR 324	2029–2037	26,730	0.21
PM10b	Financing search costs	Businesses	PO2	40 × 8 days × 0.55 × EUR 324	2029–2037	57,024	0.44
PM10c	Financing search costs	Businesses	PO3	50 × 10 days × 0.55 × EUR 324	2029–2037	89,100	0.69
PM11a	Avoided duplicated monitoring	Member States	PO1	60 × 6 days × 0.55 × EUR 380	2030–2037	75,240	0.51
PM11b	Avoided duplicated national monitoring	Member States	PO2	60 × 10 days × 0.64 × EUR 380	2030–2037	145,920	0.99
PM11c	Avoided duplicated monitoring	Member States	PO3	60 × 12 days × 0.64 × EUR 380	2030–2037	175,104	1.19
PM12a	Partner search (overlap-adjusted ×0.65)	Businesses	PO1	180 × 2 days × 0.50 × 0.65 × EUR 324	2030–2037	37,908	0.26
PM12b	Partner search (overlap-adjusted ×0.65)	Businesses	PO2, PO3	180 × 4 days × 0.70 × 0.65 × EUR 324	2030–2037	106,142	0.72
PM14a	Avoided duplicated engagement	Member States	PO1	10 × 2 days × 0.55 × EUR 380	2029–2037	4,180	0.03
PM14b	Avoided duplicated bilateral engagement	Member States	PO2, PO3	15 × 5 days × 0.64 × EUR 380	2029–2037	18,240	0.14

Measure	Saving line	Beneficiary	Options	Population × days saved × take-up (× overlap) × day rate	Years	Annual saving (EUR)	NPV (EUR million)
PM15a	Prioritisation (voluntary uptake)	Member States	PO1	115 × 6 days × 0.55 × EUR 380	2029–2037	144,210	1.12
PM15b	Faster prioritisation, reduced duplication	Member States	PO2, PO3	115 × 10 days × 0.64 × EUR 380	2029–2037	279,680	2.18
PM16a	Partner search and consortium building (overlap-adjusted ×0.65)	Businesses	PO1	80 × 3 days × 0.55 × 0.65 × EUR 324	2029–2037	27,799	0.22
	Total PO1 (13 lines)						**5.39**
	Total PO2 (14 lines)						**13.59**
	Total PO3 (14 lines)						**14.04**

Table 4.17. *Monetised saving lines by option (NPV 2028–2037)*

Table 4.18 reconciles the PO2 monetised savings by mechanism and by beneficiary.

Breakdown of PO2 modelled savings	EUR million NPV
By mechanism: coordination and duplication avoidance (capped by the fragmentation pool, Table 4.10)	6.66
By mechanism: other time and transaction-cost savings	6.93
By beneficiary: Member State authorities	6.86
By beneficiary: businesses	6.45
By beneficiary: implementing bodies	0.27
Total modelled savings (each view)	**13.59**

Table 4.18. *PO2 modelled savings by mechanism and by beneficiary (EUR million NPV, 2028–2037)*

17.11. QUALITATIVE BENEFITS

The following benefits are assessed principally through structured qualitative analysis:

- research and innovation spillovers;
- ecosystem development;
- industrial capability;
- strategic autonomy and economic security;
- trust and interoperability;
- quantum-safe preparedness;
- employment and skills;
- territorial effects;
- environmental effects; and
- fundamental rights.

The absence of monetisation does not imply that these effects are immaterial. It reflects insufficient evidence to assign a robust monetary value.

18. PART C - RESULTS, UNCERTAINTY AND QUALITY ASSURANCE

18.0. ECONOMIC IMPACTS

18.0.1. Regulatory, administrative and indirect costs

The Standard Cost Model estimates the incremental costs of governance, planning, applications, assessment, monitoring, reporting, information provision, programme administration and enforcement. It also separately identifies the possible price premium associated with European procurement conditions.

The model does not include the substantive value of grants, infrastructure investment, procurement contracts, vouchers or capital committed through financial instruments. Such expenditure depends on future budgetary decisions and is reported separately as memorandum information.

Central NPV, EUR million, 2028-2037	PO1	PO2	PO3
One-off administrative cost	0.00	1.37	8.44
Recurrent administrative cost	0.65	31.80	54.50
One-off adjustment cost	0.00	0.00	0.32
Recurrent adjustment cost	0.00	0.00	18.38
Enforcement cost (Commission and Member State authorities)	0.79	5.33	9.84
Implementation cost: Member State authorities in opt-in measures	14.06	3.40	3.40
Implementation cost: Commission administration and non-staff resources, implementing bodies, experts	23.16	39.30	43.95
Implementation cost: incremental Hub/Centre resources	0.00	21.41	21.41
Participation by firms without a legal requirement (not a compliance cost)	2.77	3.33	3.33
Total societal cost	41.44	105.92	163.56
Modelled monetised savings	5.39	13.59	14.04
Net modelled cost	36.05	92.34	149.52
Partial benefit-cost ratio	0.13	0.13	0.09

Table 4.19. *Modelled costs by category and option. Source: Commission-services Standard Cost Model. Central estimates, real prices and NPV over 2028–2037.*

Interpretation of the monetary results. All figures are central net present values for 2028-2037. Total societal cost covers the incremental real-resource costs of operating the framework, including EUR 21.41 million of illustrative marginal service and adaptation resources for existing hubs and Centres under PO2 and PO3. It excludes substantive grants, procurement expenditure and capital committed through financial instruments. Modelled monetised benefits include only demonstrable time and resource savings. They exclude wider strategic, innovation, resilience, skills, infrastructure-service and security benefits. Net modelled cost is calculated as total societal cost minus modelled cost savings. A positive figure therefore represents the residual cost under the partial monetised assessment; it does not mean that the option produces no wider benefits. Adjustment costs arise only under PO3 (EUR 7.20 million for businesses and EUR 11.50 million for public administrations). Implementation costs count as enforcement costs under Tool #56: the effort of Member State authorities in measures they opt into, Commission administration and non-staff resources (platform build and operation), implementing-body delivery, external experts and the Hub/Centre resources (PO2: EUR 3.40 million, 25.65 million, 8.44 million, 7.44 million, 0.55 million and 21.41 million). Time that firms choose to spend in the new structures without a legal requirement is not a compliance cost but is part of the societal cost (PO2: EUR 3.33 million).

The estimates were calculated using a bottom-up Standard Cost Model. For each measure, the number of affected actors was combined with the expected frequency, staff time, labour cost and other unit-resource requirements, distinguishing one-off and recurrent costs. Annual costs were expressed in 2024 prices and discounted at 3% over 2028-2037. Existing infrastructure and ordinary operating costs are included in the baseline; only incremental service and adaptation resources are counted. Transfers and financing volumes are reported separately.

The central case reuses existing infrastructure. Five hubs and fifteen existing or suitable competence/acceleration centres are illustrative costing assumptions, not predetermined policy commitments. Final numbers depend on capacity and gap assessment, competitive selection and operator-level cost validation. Construction and ordinary operating costs of existing facilities remain in the baseline. Procurement-related price effects are excluded from the central societal-cost totals. A separate low-confidence PO3 procurement premium deadweight stress scenario is approximately EUR 11.04 million NPV. It is excluded from the central societal-cost estimate and does not change the option ranking[3].

PO1 has the lowest cost because it relies mainly on voluntary coordination, guidance and information tools. PO2 entails higher costs for structured governance, Strategic Project designation, common facility arrangements, procurement coordination, standards, PQC preparedness assessment, exercises and procurement requirements and targeted dependency reporting. PO3 retains the PO2 variants for PM1-PM6, PM8, PM9, PM12 and PM14-PM16 and applies higher-intensity variants only to PM7, PM10, PM11 and PM13. These add stronger strategic procurement conditions, targeted mandatory assurance, dedicated mandate or risk-bearing finance capacity, wider mandatory dependency reporting and binding PQC-preparedness duties.

Cost bearer	PO1	PO2	PO3
Commission and Union services	EUR 22.32m	EUR 38.07m	EUR 43.47m
Member State authorities/public buyers	EUR 14.51m	EUR 30.81m	EUR 64.54m
Implementing bodies/JUs	EUR 1.81m	EUR 6.26m	EUR 6.37m
Existing Hub/Centre operators: marginal services and adaptation	EUR 0.00m	EUR 21.41m	EUR 21.41m
Businesses/private actors	EUR 2.77m	EUR 8.83m	EUR 26.94m
External experts	EUR 0.03m	EUR 0.55m	EUR 0.83m
Total	EUR 41.44m	EUR 105.92m	EUR 163.56m

Table 4.20. *Distribution of costs by bearer*

Cost category, EUR million NPV	PO1	PO2	PO3
Administrative burden on businesses	0.00	5.50	16.41
of which within One-In, One-Out	0.00	5.46	16.28
Administrative burden on public administrations	0.45	26.06	44.93
Administrative burden on implementing bodies	0.20	1.60	1.60
Business adjustment costs	0.00	0.00	7.20
Adjustment costs for public administrations	0.00	0.00	11.50
Enforcement costs (Commission and Member State authorities)	0.79	5.33	9.84
Implementation costs: Member State authorities in measures they opt into	14.06	3.40	3.40
Implementation costs: Commission administration	18.39	25.65	29.91

[3] The procurement-premium estimate depends on expert-judgement parameters concerning the affected procurement share, possible price difference and annual coordinated-pipeline value. The PM7c fiche should define the eligible geographical scope, market-availability test, exceptions and relationship with Directive 2014/24/EU and Directive 2014/25/EU on public procurement; Regulation (EU) 2022/1031, the WTO *Agreement on Government Procurement* and relevant Union international agreements.

Implementation costs: external experts financed by the Commission	0.03	0.55	0.83
Implementation costs: implementing-body delivery	1.61	4.66	4.77
Implementation costs: Commission non-staff resources (platform build and operation)	3.14	8.44	8.44
Implementation costs: incremental Hub/Centre resources (publicly funded operators)	0.00	21.41	21.41
Participation by firms without a legal requirement (not a compliance cost)	2.77	3.33	3.33
Total societal cost	**41.44**	**105.92**	**163.56**

Table 4.21. *Costs by category, reconciled with total societal cost*

Displayed bearer components are individually rounded; headline totals are calculated from unrounded workbook values. Approximately 65.0% of PO2 societal costs fall on Commission/Union services and Member State authorities. Including implementing bodies, facility operators and Commission-financed external experts, the public and implementation share is approximately 91.7%. Business-facing costs are concentrated on applicants, beneficiaries, designated Strategic Projects and actors subject to narrowly scoped information requirements. They do not apply to the general quantum-business population.

Under the One-In, One-Out methodology, new administrative burdens on businesses are estimated at EUR 5.46 million NPV under PO2, equivalent to approximately EUR 0.621 million annually, and EUR 16.28 million NPV under PO3, equivalent to approximately EUR 1.853 million annually[4]. These figures include the requirements for taking part in regulatory sandboxes and the business platform (EUR 0.68 million) and the evidence that bidders provide on PQC requirements in public procurement (EUR 1.23 million). Documentation for investment support under PM10 (EUR 0.05 million under PO2 and EUR 0.13 million under PO3) is an administrative cost but, as an application for financial support, is not offset.

Common templates, digital procedures, proportionate thresholds, technical assistance and once-only reuse of information are expected to reduce costs. Their effects are included within the modelled savings and are not counted separately under an additional simplification measure.

[4] European Commission, *Better Regulation Toolbox*, 2025, Tools #56, #58 and the One-In, One-Out methodology. Detailed activities, populations, frequencies, per-firm estimates and bearer allocations are provided in this Annex.

Table 4.22 shows how each cost line of Table 4.21 is calculated, for each option, with its main inputs. Annual values are discounted to 2028 at 3%: the discount factors sum to 8.78611 over 2028–2037, 7.78611 over 2029–2037 and 6.81524 over 2030–2037.

Cost line	PO1	PO2	PO3	Calculation and main inputs (EUR million NPV unless stated)
Administrative burden on businesses	0.00	5.50	16.41	Firms × person-days × EUR 324 a day (Table 4.15). PO2: Union funding 2.10 (PM1b metadata from 180 funded beneficiaries: 180 × 3.5 days = EUR 204,120 in 2028, then 180 × 3.75 days = EUR 218,700 a year; PM3b reporting by 15 consortia, 0.19); Strategic Project designation 0.92 (applications 0.33, reporting 0.48, safeguards 0.10); supported procurement 0.07 (10 bidders × 3 days a year); PQC requirements in public procurement 1.23 (evidence from bidders, 270 procedures × 60% × 3 days a year from 2029); targeted requests 0.48 (45 firms × 3.5 days in 2029, then × 3.75 days a year); participation requirements 0.72 (36 sandbox participants × 8 days = EUR 93,312 a year from 2030, 0.64; platform onboarding of 126 firms in 2029, 0.04; documentation for investment transactions, 0.05, not offset). PO3: funding, designation, sandbox and platform as PO2 (3.69), PQC requirements in public procurement as PO2 (1.23), binding PQC duties for 180 critical operators 10.40 (plans 2.55, plan updates 4.11, progress reports 2.38, 20% of inventory maintenance 1.36), dependency reporting by 80 firms 0.84, origin documentation by 18 bidders 0.12 and transaction documentation 0.13, not offset. PO1 imposes no obligation.
of which within One-In, One-Out	0.00	5.46	16.28	All of the above except documentation for investment support (PO2 0.05; PO3 0.13), an application for financial support (Tool #58, Box 4). Annualised: NPV ÷ 8.78611 = EUR 0.621 million a year (PO2) and EUR 1.853 million a year (PO3).
Administrative burden on public administrations	0.45	26.06	44.93	Member States × person-days × EUR 380 a day. PO2: Quantum Strategy Board 13.72 (position work 27 × 120 days = EUR 1,231,200 a year, 10.82; meeting preparation 56 delegates × 12 days, 2.24; sub-groups and set-up 0.65); dependency-monitoring contributions 27 × 60 days = EUR 615,600 a year from 2029, 4.79; national chapters 3.58 (set-up 27 × 90 days in 2028, updates every two years, alignment sessions); international coordination 0.72; sandbox cycles 0.47; other 0.48; PQC preparedness 2.31 (national information for the biennial assessment, 27 × 30 days every two years, 1.35; specification and verification of PQC requirements by contracting authorities, 270 procedures × 60% × 2 days a year from 2029, 0.96). PO3 adds binding PQC duties for 270 critical public authorities 18.30 (plans 4.48, plan updates 7.23, progress reports 4.20, 20% of inventory maintenance 2.40), mitigation-plan follow-up 1.40 and procurement safeguards 0.12; the verification of PQC requirements by contracting authorities (0.96) is replaced by PQC-ready procurement administration (adjustment costs). PO1: skills focal points, 27 × 5 days a year, 0.45.
Administrative burden on implementing bodies	0.20	1.60	1.60	Reports by hub and Centre operators at EUR 261.60 a day: hubs, 2 × 60 days a year from 2029 and 3 more from 2031 (0.52); Centre nodes, 8 × 40 days a year from 2029 and 7 more from 2031 (1.08). PO1: 5 labelled facilities × 20 days a year (0.20).
Business adjustment costs	0.00	0.00	7.20	PO3 only: 80% of cryptographic-asset inventory maintenance by 180 critical operators (180 × 15 days × EUR 324 a year, 5.45), PQC-ready procurement administration (1.09) and PM11c mitigation plans of 30 critical firms (0.66).
Adjustment costs for public administrations	0.00	0.00	11.50	PO3 only: 80% of inventory maintenance by 270 critical public authorities (270 × 15 days × EUR 380 a year, 9.59) and PQC-ready procurement administration (1.92).

Enforcement costs (Commission and Member State authorities)	0.79	5.33	9.84	PO2: Commission 3.98 (PM5b designation, monitoring and withdrawal, 562.5 days a year (2.5 FTE) from 2029 = EUR 325,000 a year, 2.53; comply-or-explain enforcement 0.76; gate reviews 0.32; verification of dependency reports 0.36); Member States 1.35 (comply-or-explain responses 27 × 10 days a year, 0.80; origin verification 0.31; participation in coordinated PQC exercises, 27 × 6 days every two years from 2029, 0.24). PO3 replaces the PM7b and PM11b lines (origin verification and trade-defence work 1.11; reporting enforcement 0.45) and adds supervision of the PQC duties (3.62). PO1: Commission monitoring (0.79).
Implementation costs: Member State authorities in measures they opt into	14.06	3.40	3.40	PO2 and PO3: buyer-group coordination, 5 Member States × 120 days = EUR 228,000 a year from 2029 (1.78); incremental effort in 8 pre-commercial or innovation procurements a year × 60 days (1.42); PQC expert time (0.20). PO1, where all Member State effort is voluntary: Board participation 6.81 (position work 27 × 60 days a year, 5.41); mapping input 27 × 30 days a year (2.70); monitoring contributions 27 × 30 days a year (2.40); buyer group of 5 Member States (1.33); programming exchanges 27 × 0.64 × 6 days a year (0.35); other (0.47).
Implementation costs: Commission administration	18.39	25.65	29.91	Commission staff time at EUR 577.78 a day, i.e. the FTE of Table 4.14 × EUR 130,000 a year, discounted. PO2: 22.32 FTE in 2028, 26.21 in 2029 and on average 26.43 a year in 2030–2037, EUR 29.63 million in total, of which 25.65 administration and 3.98 enforcement. Largest functions: quantum-safe preparedness 4.57 (PM13b), dependency monitoring 4.47 (PM11b), EU chapter 3.91 (PM1b), Quantum Strategy Board 3.35 (PM15b) and Investment Advisory Facility 3.30 (PM10b). PO1: 16.81 FTE on average; PO3: 30.75 FTE (adds the PM7c, PM10c, PM11c and PM13c tasks).
Implementation costs: external experts financed by the Commission	0.03	0.55	0.83	Person-days × EUR 450 a day. PO2 and PO3: standardisation requests, 2 × 80 days × 40% = 64 days a year (0.25); Grand Challenge gate reviews, 48 days a year from 2029 (0.17); portfolio and gap review, 30 days a year (0.11); legal-form review, 48 days in 2032 (0.02). PO3 adds financial, legal and valuation support for a European co-investment, 2 × 40 days a year (0.28). PO1: competence-framework mapping, 60 days in 2028 (0.03).
Implementation costs: implementing-body delivery	1.61	4.66	4.77	PO2 and PO3: six coordination and oversight tasks transferred from the Commission and priced at its rate of EUR 577.78 a day (5.08): Centre network oversight and voucher administration, 500 days a year (2.25); excellence-network coordination and hub-network oversight, 450 days × 0.6 a year each (1.21 each); calls in 2028 (0.40). Other tasks at EUR 261.60 a day (2.36): Joint Undertaking metadata and briefings (1.12), laboratory participation in the excellence network, 30 × 15 days a year (0.92), sandbox cycles (0.32). At EUR 261.60 a day the six tasks would cost EUR 2.78 million less. PO3 adds post-investment monitoring (0.11). PO1: laboratories, signposting nodes and Joint Undertakings (1.61).
Implementation costs: Commission non-staff resources (platform build and operation)	3.14	8.44	8.44	Cash costs of the Quantum Business Platform (PM12), from the Union budget. PO2 and PO3: build stage 1, EUR 800,000 in 2028 (0.80); stage 2, EUR 700,000 in 2029 (0.68); stage 3, EUR 2,500,000 in 2031 (2.29); operation, EUR 600,000 a year in 2029–2037 (4.67). PO1: build, EUR 800,000 in 2028 (0.80), and operation, EUR 300,000 a year in 2029–2037 (2.34).
Implementation costs: incremental Hub/Centre resources (publicly funded operators)	0.00	21.41	21.41	Marginal services at 5 existing hubs, EUR 0.50 million each a year in 2030–2037 (17.04), and one-off adaptation of 15 existing Centres, EUR 0.30 million each, a third in each year 2028–2030 (4.37) (Table 4.11).
Participation by firms without a legal requirement (not a compliance cost)	2.77	3.33	3.33	Firms × days × EUR 324 a day. PO2 and PO3: Alliance stakeholder input, 200 × 2 days = EUR 129,600 a year (1.14); standards-body experts (15 × 20 days a year), testing references and Advisory Board time (1.29); platform input by 126 firms × 2 days a year and matchmaking (0.73); PQC expert time (0.17). PO1: participation in the voluntary PO1 measures (2.77).

Total societal cost	**41.44**	**105.92**	**163.56**	**Sum of the lines above. Small differences are due to rounding.**

Table 4.22. *Calculation of the cost lines by option (EUR million NPV, 2028–2037)*

18.1. PATENT EVIDENCE

The EPO analysis covers more than 31,700 published patent families with earliest publication years between 2005 and 2024 across quantum computing and simulation, quantum communication and quantum sensing. The revised applicant table uses unweighted counts of international patent families with filings in IP5 jurisdictions and identifies applicants at local-establishment level. “Europe” means the 40 EPC contracting states and is not interchangeable with the EU27. Patent counts proxy inventive activity, protection strategy, internationalisation and portfolio concentration; they do not measure patent quality, commercialisation, freedom to operate or market power. Results are sensitive to the search and classification strategy, publication lag, applicant-name consolidation, geographic attribution and multi-applicant counting. No causal effect of the Quantum Act is inferred from these data

18.2. OPTION AGGREGATION

Measure-level costs and modelled savings are aggregated into option-level results using the following rules:

1. PO0 is the counterfactual and has no incremental Quantum Act cost.
2. PO1 contains 16 voluntary, advisory or enabling PM variants; one from each of PM1–PM16, including the voluntary PM3a challenge-mapping variant.
3. PO2 contains one targeted framework variant from each of PM1–PM16.
4. PO3 contains one higher-intensity or retained PO2 variant from each of PM1–PM16; PM15 uses a voluntary technical-coordination variant under PO1 and the same structured implementation-support variant under PO2 and PO3.
5. Each PM family contributes only the cost items activated for the relevant option.
6. Shared governance, reporting, data and platform activities are counted once.
7. Construction and ordinary operation of existing infrastructures remain in the baseline; the central case counts only incremental services and adaptation.
8. Programme expenditure, transfers and financing volumes are reported separately from societal resource cost.
9. Benefits affecting the same firm, project, facility or transaction are not summed across several PMs.
10. Physical, financial and qualitative scenarios with different units or counterfactuals are not aggregated into a single benefit total.

18.3. AVOIDING DOUBLE COUNTING

The following rules are applied throughout the model and impact analysis:

Area	Anti-double-counting rule
Administrative information	Where the same information supports governance, Strategic Project monitoring, business-platform functions, strategic intelligence or dependency assessment, its provision is costed once. Existing information is reused before a new request is created.
Governance and programming	General governance benefits under PM1, PM15 and PM16 are not monetised separately where they are already reflected in modelled time or coordination savings.

Research, infrastructure and deployment	PM2–PM6 may affect the same research-to-deployment pathway. A time saving from earlier access, testing, qualification or project coordination is counted once.
Finance, Strategic Projects and procurement	PM5.2, PM7 and PM10may affect the same company or project. Financing volumes, supplier revenue and procurement expenditure are not summed as welfare benefits or added to the same transaction more than once.
Standards and assurance	Reduced testing, due-diligence or qualification costs are attributed once even where PM4, PM7 and PM8 all contribute.
Skills and user support	PM6 and PM9 may support the same beneficiary. Participation and support costs are allocated to the principal activity and are not duplicated.
Quantum-safe preparedness	The substantive PQC migration cost arises under the baseline. PO1 adds no PQC-specific cost beyond the baseline. Under PO2, only the incremental costs of the preparedness assessment, the exercises, the evidence and verification required by PQC requirements in public procurement and structured QSB–NIS Cooperation Group cooperation are attributed to the Act, while the cost of the PQC-capable products bought stays in the baseline; PO3 additionally includes the incremental costs of the targeted binding roadmap-implementation duties.
Strategic intelligence and resilience	PM11 and PM14 may draw on the same dependency information. Mapping benefits are not added again where the same evidence supports mitigation, procurement or international cooperation.
Simplification	Common taxonomies, templates, digital procedures and once-only reuse are incorporated in the affected PM cost and saving items. They are not counted as a separate benefit category

Table 4.23. *Anti-double-counting rules*

18.4. CENTRAL OPTION-LEVEL RESULTS

The central existing-infrastructure-reuse case produces the following results. Values are EUR million, present value over 2028–2037 in real 2024 prices.

Central result	PO1	PO2	PO3
Total societal cost	41.44	105.92	163.56
Evidenced monetised savings	5.39	13.59	14.04
Signed monetised NPV: savings minus cost	-36.05	-92.34	-149.52
Positive net modelled cost: cost minus savings	36.05	92.34	149.52
Partial benefit-cost ratio	0.13	0.13	0.09

Table 4.24. *Policy Options monetised costs and benefits*

All partial benefit-cost ratios are below one because the model monetizes only modelled process and transaction-cost savings with an explicit causal mechanism and deliberately excludes most strategic and capability benefits. The monetary results therefore do not, on their own, demonstrate positive net welfare. The preferred option is identified after combining these results with the qualitative impact assessment, proportionality analysis, implementation feasibility and MCDA.

Complementary analytical view	PO1	PO2	PO3
Business administrative burden within One-In, One-Out, NPV	0.00	5.46	16.28
Equivalent annual business administrative burden	0	EUR 0.621m/year	EUR 1.853m/year
Layer 2 – EU and Member State administrative and implementation expenditure at resource rates, EUR million NPV	36.83	90.28	129.42

Table 4.25. *Administrative-burden and budgetary views*

Layer 2 is the EU and Member State administrative and implementation expenditure costed at resource rates: EUR 90.28 million NPV for PO2, of which EUR 68.87 million for EU and Member State tasks and EUR 21.41 million for the hub and Centre module. Implementing-body work (EUR 9.05 million) and external experts (EUR 0.55 million) are financed from

the Union budget but sit outside Layer 2. Programme envelopes and transfers are not part of Layer 2: they are reported separately and must not be added to societal cost or treated as a welfare benefit.

18.5. SENSITIVITY ANALYSIS

Deterministic sensitivity analysis varies participation, reporting frequency, affected populations, staff time and rates, infrastructure-service and adaptation resources, private-finance leverage, procurement parameters, targeted information requests, data reuse and the strength of the dynamic baseline. Low and high assumptions are plausible implementation cases, not statistical confidence intervals.

Infrastructure-resource case	PO1 total cost	PO2 total cost	PO3 total cost	PO2 incremental implementation resources	Interpretation
RC-L – Low marginal/adaptation cost	41.44	94.49	152.12	9.98	Low marginal service and adaptation costs
RC0 – Central existing-infrastructure reuse	41.44	105.92	163.56	21.41	Central existing-infrastructure reuse case
RC-H – High marginal/adaptation cost	41.44	149.96	207.60	65.45	High marginal service, adaptation and specialist support
Full-build stress	41.44	689.99	747.62	605.47	Counterfactual construction and full-operation case

Table 4.26. *Sensitivity to infrastructure-service and adaptation assumptions, EUR million NPV*

Uncertainty in the monetised results is tested through a deterministic scenario suite covering resource intensity, consolidation economies, price-year treatment, discount rate and a combined adverse case. Each scenario varies a defined lever and is recalculated in full. The suite establishes the range within which the option ranking holds; it does not express results as probabilities.

A transparent MCDA (**Table 4.32**) supplements, but does not replace, the reasoned comparison in the Main Report. Criteria, scores and weights are disclosed, and the results are used as decision support rather than as a mechanical rule.

PO2 remains first under the central weighting because it combines broad effectiveness with targeted scope, use of existing structures and lower burden than PO3. PO3 may overtake PO2 only where substantially greater weight is placed on its additional formal coverage in selected strategic criteria.

18.6. IMPLEMENTATION-RESOURCE SCENARIOS

The main uncertainty concerning the infrastructure-related measures is not the construction of new facilities, which is excluded from the central option design, but the marginal cost of delivering additional services through existing hubs and adapting existing Centres.

The full-build stress scenario is not the central policy design. It shows the possible cost if existing infrastructure could not be reused and construction and full facility operation had to be attributed to the initiative.

In the full-build stress scenario, the principal incremental components are approximately EUR 194.23 million NPV of hub capital expenditure, EUR 340.76 million of full facility operating expenditure and EUR 131.79 million of full node operations, partly offset by an estimated EUR 61.31 million residual-value credit (net EUR 605.47 million).

18.7. DETERMINISTIC SENSITIVITY ANALYSIS

Signed net NPV in EUR million; benefits minus costs:

Scenario	PO1	PO2	PO3
Central existing-infrastructure case	-36.05	-92.34	-149.52
Low marginal service/adaptation costs	-36.05	-80.90	-138.09
High marginal service/adaptation costs	-36.05	-136.38	-193.56
PO3 service intensity 1.5 times central	-36.05	-92.34	-160.23
One-year implementation delay	-36.05	-89.85	-147.04
Two-year implementation delay	-36.05	-87.44	-144.63
20% implementation-resource overrun	-36.05	-96.62	-153.80
40% implementation-resource overrun	-36.05	-100.90	-158.08
Modelled benefits 20% lower	-37.13	-95.05	-152.33
Modelled benefits 20% higher	-34.97	-89.62	-146.71
Full-build stress	-36.05	-676.40	-733.58
50% user-fee recovery	-36.05	-92.34	-149.52
Stronger baseline: Assumption that 25% of savings and of Member State effort in opt-in measures would occur anyway	-33.88	-94.88	-152.14
Participation shares at low values (53% / 40%)	-37.08	-94.01	-151.30
Participation shares at high values (75% / 75%)	-34.66	-90.62	-147.68
Member State day rate EUR 320	-34.26	-88.56	-140.45
Member State day rate EUR 440	-37.84	-96.12	-158.60
Discount rate 1.5% instead of 3%	-38.36	-98.34	-159.54
Discount rate 4.5% instead of 3%	-33.97	-86.92	-140.49
PM13c covered entities low (250) / high (800) [PO3 only]	-	-	-127.54 / -188.03
Combined adverse case including the high PM13c population	-41.58	-149.27	-245.86

Table 4.27. *Scenario analysis*

Implementation delay makes the discounted monetary result mechanically less negative because expenditure occurs later. This should not be interpreted as a policy advantage, since the table does not monetise, the benefits lost through delayed delivery.

Discounting at 1.5% or 4.5% instead of 3% moves all options in the same direction (PO2 net modelled cost EUR 98.34 million or EUR 86.92 million) and does not change their order.

Fee recovery has no effect on societal net present value because it transfers resources between users and the public operator. It affects the distribution of budgetary costs only.

Across the deterministic tests, PO1 remains the least costly option and PO2 remains less costly than PO3. In the participation cases costs barely move while savings change; in the stronger-baseline case both savings and Member State effort in opt-in measures fall, so costs and savings move together. The PM13c population is the single most influential assumption for PO3. This result concerns the partial monetised assessment and does not determine the overall preferred option.

18.8. SWITCHING VALUES

Switching values indicate the additional benefits or cost reductions that would be required for the modelled monetised benefits to equal the modelled societal costs.

Switching-value indicator	PO1	PO2	PO3

Additional annual benefit required for net NPV of zero, 2029–2037	EUR 4.63m/year	EUR 11.86m/year	EUR 19.20m/year
Required multiplier on modelled benefits	7.69×	7.80×	11.65×
Required reduction in total modelled cost	87.0%	87.2%	91.4%
Marginal hub cost recreating full-build stress	Not applicable	EUR 17.64m per hub/year	EUR 17.64m per hub/year
Centre-adaptation cost recreating full-build stress	Not applicable	EUR 40.39m per Centre	EUR 40.39m per Centre
Effect of fee recovery on societal NPV	Zero	Zero	Zero

Table 4.28. *Switching values outcomes*

The high benefit multipliers illustrate the incompleteness of the monetised benefit perimeter. They should not be interpreted as evidence that the options could not generate benefits of that order. Rather, they show how much non-monetised value would have to be demonstrated for a complete welfare balance to reach zero.

18.9. STRATEGIC AND LOW-CONFIDENCE BENEFIT SCENARIOS

Some potentially material impacts could not be included in the central calculation because their probability, scale or attribution could not be estimated with sufficient confidence.

Scenario	Low	Reference	High	Treatment and interpretation
Systemic GDP at risk	EUR 0.40bn	EUR 1.50bn	EUR 3.00bn	Contextual stress indicator only; never included in NPV
PO3 procurement-premium deadweight cost	EUR 0	EUR 0	EUR 11.04m	Low-confidence stress scenario; worsens PO3 but does not change the ranking
Stop-rule avoided sunk costs	Not monetised	Not monetised	Not monetised	Probability of project failure at stage gates is not sufficiently established
Financing additionality	Not monetised	Not monetised	Not monetised	Requires ex post counterfactual evaluation
Long-run R&D and innovation spillovers	Not monetised	Not monetised	Not monetised	Causal and temporal uncertainty is too high for the central model
Infrastructure-service value	Not monetised	Not monetised	Not monetised	Requires operator and user evidence on additional service volumes and willingness to pay

Table 4.29. *Strategic and low-confidence scenarios excluded from the headline results*

The systemic GDP-at-risk figures (EUR 0.40 / 1.50 / 3.00 billion) are contextual stress indicators, not forecasts, and never enter the NPV. They are not and must not be considered on the central benefits.

Uncertainty in the monetised assessment is addressed through deterministic scenarios, workload ranges, switching values combined adverse cases and a probabilistic analysis of the registered uncertainty ranges. The probabilistic results are reported in the following section. They describe the dispersion of the modelled cost around the central case; they do not alter the central estimates, which remain the reference figures throughout this Impact Assessment.

18.10. PROBABILISTIC UNCERTAINTY ANALYSIS

The deterministic scenarios above vary one lever, or a defined bundle of levers, at a time. They show how far the results can move, but not how likely any outcome is. A probabilistic analysis was therefore run on the same model. Each of the 313 modelled cost and benefit lines was drawn simultaneously from a triangular distribution defined by the low, central and high values already registered for that line in the calculation workbook, together with the Commission day-rate band and the marginal service and adaptation band. The discount rate is held at 3%. Dependence between lines uses the correlation parameters registered in

the workbook. The run comprises 200 000 iterations and reproduces the deterministic central case exactly when every draw is set to its central value.

Option	Central case	Mean	P50	P80	P95
PO1	41.44	47.95	47.84	51.47	54.97
PO2	105.92	132.92	131.90	145.73	158.69
PO3	163.56	226.15	224.41	251.92	278.55

Table 4.30. *Probabilistic distribution of total societal cost on the registered uncertainty ranges, EUR million NPV, 200 000 iterations*

The dispersion in Table 4.30 - between P50 (50th percentile), P80 (80th percentile) and P95 (95th percentile) - should not be read as evidence that the central estimates are too low. It reflects the shape of the ranges recorded in the model. For 95% of the modelled lines the registered high value lies further above the central value than the low value lies below it, and the asymmetry is systematically wider where the evidence is weaker: the ratio of upside to downside is 1.0 for lines rated High, 1.9 for Medium and 2.6 for Low. Part of the difference between the central case and the median outcome is therefore a property of how uncertainty was recorded under weak evidence, rather than a measurement of expected cost.

The probabilistic results are reported as evidence on dispersion and on evidence priorities. They do not replace the central estimates, and they inherit the limitations of the ranges they sample.

18.11. MULTI-CRITERIA DECISION ANALYSIS (MCDA)

A multi-criteria decision analysis was used as a structured transparency and decision-support tool. It supplements, but does not replace, the reasoned comparison of the policy options. Its purpose is to bring together the partial monetised assessment and material qualitative effects that cannot be expressed reliably in monetary terms.

The retained options were assessed against eight criteria: effectiveness; efficiency; coherence; proportionality; feasibility and implementation risk; competitiveness and SME effects; resilience and economic security; and social, skills and cohesion effects. Scores use an ordinal scale from 1 to 5, where a higher score represents more favourable performance. Intermediate scores distinguish comparatively close judgements but do not imply statistical precision.

The balanced reference case assigns an equal weight of 12.5% to each criterion. Equal weighting is used as a transparent reference because there is no empirical basis for assigning more precise central weights. The weighted score for each option is calculated as the sum of its criterion scores multiplied by the corresponding weights. Criteria, scores and weights remain policy judgements rather than statistically estimated parameters.

18.11.1. Criteria, definitions, central weights and principal evidence

The criteria, definitions, central weights and principal evidence sources are set out in table below:

Criterion	Definition and scoring direction	Central weight	Principal evidence
Effectiveness	Credible coverage and delivery of SO-A–SO-G, excluding downstream impacts scored separately. Higher means stronger delivery.	12.5%	Intervention logic, Table 8.13 and Impact Register
Efficiency	Evidenced benefits relative to incremental societal resource cost. Higher means a more favourable cost-effectiveness position.	12.5%	Table 4.19 and Table 4.24 and sensitivity analysis
Coherence	Complementarity with existing Union instruments and avoidance of duplication or conflict.	12.5%	Baseline and coherence analysis
Proportionality	Targeting and legal or administrative intrusiveness relative to the problem addressed. Higher means more proportionate.	12.5%	Legal analysis and administrative-burden assessment
Feasibility and implementation risk	Deliverability within the available institutional capacity, resources and timetable.	12.5%	Commission, Member-State and delivery-body resource analysis
Competitiveness and SME effects	Expected effects on industrial capability, market access and SMEs, net of direct burdens.	12.5%	Competitiveness Check, SME analysis and OIOO results
Resilience and economic security	Expected contribution to supply-chain, technological and quantum-safe resilience.	12.5%	Impact Register and dependency/PQC analysis
Social, skills and cohesion	Expected skills, employment, distributional and territorial effects.	12.5%	Skills and distributional-impact analysis

Table 4.31. *MCDA criteria, definitions and weights*

The aggregation formula is:

$$S_o = \sum_{k=1}^{8} w_k s_{ok}$$

where $s_{ok}$is the score of option on criterion *k*, and the weights sum to one.

18.11.2. Double-counting controls

Double counting is controlled by distinguishing the role of each criterion. Effectiveness concerns the credible coverage and delivery of the policy objectives. Efficiency uses the societal-cost and modelled-benefit perimeter of the cost-benefit analysis and does not use total public-budget outflow. Proportionality concerns the targeting and intrusiveness of the intervention, while feasibility concerns administrative and institutional deliverability. Competitiveness, resilience and social effects cover impact-specific consequences not already counted in the effectiveness score.

Criterion	Weight	PO0	PO1	PO2	PO3
Effectiveness	12.5%	1.00	2.75	3.75	4.25

Efficiency	12.5%	3.00	3.75	2.50	1.25
Coherence	12.5%	2.00	3.00	4.00	4.00
Proportionality	12.5%	4.00	4.00	3.50	2.25
Feasibility and implementation risk	12.5%	4.00	4.00	3.00	2.00
Competitiveness and SME effects	12.5%	1.50	2.50	3.50	3.75
Resilience and economic security	12.5%	1.00	2.00	3.75	4.50
Social, skills and cohesion	12.5%	1.50	2.00	3.50	3.50
Weighted score	**100%**	**2.250**	**3.000**	**3.438**	**3.188**
Rank among retained options		—	**3**	**1**	**2**

Table 4.32. *MCDA central score matrix*

PO0 is included as a baseline reference but is not a retained option.

18.11.3. Rationale for the scores

Effectiveness: PO1 relies predominantly on voluntary coordination. PO2 introduces structured EU-wide planning, support and implementation mechanisms. PO3 adds targeted binding preparedness, assurance, dependency-reporting and procurement requirements.

Efficiency: PO1 has the lowest partial monetised net cost. PO2 costs more but provides wider coverage. PO3 has the highest cost and burden within the quantified perimeter.

Coherence: PO2 and PO3 use comparable coordination interfaces with existing Union legislation and programmes; PO3's additional binding layer does not itself increase coherence.

Proportionality: PO1 is least intrusive. PO2 remains targeted and mainly uses existing structures. PO3 adds binding requirements.

Feasibility: PO3 requires a larger supervisory and compliance-review function than PO2. PO1 is easiest to administer but delivers fewer policy mechanisms.

Competitiveness and SME effects: PO2 improves access, coordination and scale-up support with lower direct burden than PO3. PO3 provides stronger formal coverage but introduces materially higher business-facing obligations.

Resilience and economic security: PO3 scores highest because it adds binding preparedness and reporting requirements. PO2 provides structured implementation support without the same mandatory coverage.

Social, skills and cohesion: PO2 and PO3 retain the same principal skills architecture. No sufficiently direct additional PO3 effect has been demonstrated, so they receive the same score.

Under the balanced central weighting case, PO2 obtains the highest weighted score. It provides materially stronger and more structured delivery than PO1 while avoiding part of the legal intensity, administrative burden and implementation risk associated with PO3. PO3 scores higher on effectiveness and resilience but lower on efficiency, proportionality and feasibility.

18.11.4. Robustness of the MCDA results

Because both scores and weights can be considered judgemental, and the ranking is weight dependent, the stability of the result was tested under alternative weighting assumptions and criterion-exclusion tests.

Test	PO1	PO2	PO3	Result

Balanced: 12.5% each	3	3.438	3.188	PO2 first
Efficiency-heavy: efficiency 30%, others 10%	3.15	3.25	2.8	PO2 first
Security-heavy: resilience 30%, others 10%	2.8	3.5	3.45	PO2 and PO3 very close
Competitiveness criterion excluded	3.071	3.429	3.107	PO2 first
Efficiency criterion excluded	2.893	3.571	3.464	PO2 first

Table 4.33. *MCDA Robustness test results*

Under all tested scenarios, PO2 remains ahead of the alternative options. But on the security-heavy case, PO2 is narrowly first, in this test PO3 would overtake PO2 only if the resilience and economic-security criterion received a weight above approximately 34.4%, with other weights adjusted proportionally. This threshold does not provide a probability or empirical estimation, but shows how much more relevant than the other weights, security criterion would have to be in order to change the results. In that case, all other criteria would need to have a weight below 9.38%, while security would have to dominate the results with a weight of 34.4%.

18.11.5. MCDA-specific limitations

The MCDA alone does not demonstrate that a policy option has a positive monetised net benefit and does not mechanically determine the preferred option. It makes explicit the policy judgements needed to combine monetised costs, qualitative impacts, proportionality and implementation considerations. The preferred option therefore continues to rest on the reasoned assessment of the evidence as a whole.

18.12. LIMITATIONS

The analysis is subject to substantial technological, market, implementation and data uncertainty. Quantum technologies differ in maturity, capital intensity, supply chains and applications, and the timing and scale of breakthroughs cannot be forecast reliably. Company, investment and procurement databases are not exhaustive. Infrastructure mappings do not always reveal actual utilisation, available capacity, waiting times or contractual barriers. Supplier mapping is selective and constrained by confidentiality and limited visibility beyond direct suppliers.

The model deliberately monetises only incremental resources and modelled time or transaction-cost savings. It does not monetise most expected effects on industrial capability, innovation spillovers, firm growth, infrastructure-service value, strategic resilience, cybersecurity preparedness, employment or long-term productivity. A negative signed monetised NPV therefore does not imply that an option has no strategic or societal value; it means that the quantified savings are lower than the modelled costs within the deliberately partial monetary perimeter.

The central case assumes reuse of existing infrastructure and includes illustrative marginal service and adaptation resources. The full-build case is a stress test and should not be presented as the expected cost of the preferred option. Programme-resource scenarios depend on future budgetary decisions and are not fixed by the Regulation.

The assessment mitigates these limitations by triangulating evidence, distinguishing observations from assumptions, avoiding unsupported forecasts, presenting low/central/high probabilistic and deterministic sensitivity results, applying conservative anti-double-counting rules, separating societal, budgetary and financing views, and defining monitoring indicators that will permit ex-post validation.

1. The model does not value the service received by users of hubs and Centres. These costs are therefore included without an offsetting service-value benefit.

2. Take-up affected populations and staff-time assumptions are necessarily uncertain because the initiative has not yet been implemented.
3. The model cannot reliably monetise long-term innovation, resilience, strategic-autonomy, skills, cohesion or productivity effects.
4. The PO2 programme-resource envelope depends on future Multiannual Financial Framework, programme-legislation and national-budget decisions.
5. The model assumes that existing laboratories and Centres can be reused. The full-build scenario shows that the results would be materially different if substantial new construction became necessary.
6. The policy measures, projects, technologies and portfolio allocations will evolve. The model is therefore an appraisal tool and not a predetermined implementation plan.

The model should be updated during implementation using observed participation, time requirements, utilisation rates, administrative burdens, project performance, service volumes and unit costs. Monitoring should distinguish SMEs from larger businesses, host from non-host Member States and different categories of infrastructure users.

19. PART D – INDICATIVE PROGRAMME-RESOURCE ENVELOPE FOR PO2, 2028-2034

19.0. PURPOSE, SCOPE AND ANALYTICAL BOUNDARY

The administrative, adjustment and implementation costs estimated elsewhere in this Annex concern the operation of the regulatory, governance and delivery framework established by the initiative. They do not represent the substantive programme resources that could be required to finance Quantum Grand Challenges, Strategic Projects, infrastructures, shared-access measures, innovation procurement, skills, standards, dependency mitigation or other programme actions.

This section therefore presents a separate bottom-up estimate of the programme resources that could support implementation of Policy Option 2 over the period 2028–2034. The estimate is intended to illustrate the order of magnitude and composition of the resources that could be required to implement the preferred option with sufficient scale and continuity.

The estimate is not a financing proposal, a forecast of future appropriations or a list of pre-selected projects. It does not create an automatic funding entitlement for any project, facility, company or Member State. Actual resources would remain subject to the future Multiannual Financial Framework, programme legislation, annual Union budgetary procedures, national and regional budgetary decisions, applicable State-aid and procurement rules and individual project-selection and investment decisions.

The following analytical conventions apply:

- the amounts are indicative, non-discounted planning amounts for 2028–2034; no separate inflation uplift is applied;
- the estimate covers new or incremental action under the preferred option. Activities already financed under the dynamic baseline are excluded unless the estimate concerns an identifiable expansion, upgrade or additional cross-border service;
- Union, Member State and industry contributions are estimated separately at measure level. The resulting portfolio-level distribution does not imply a uniform co-financing rate for every action;
- Member State contributions may comprise national and regional resources and other public co-financing attributable to participating Member States;

- industry contributions represent direct project-level co-investment, in-kind contributions where eligible and verifiable, co-funded reference deployments and private-user participation;
- additional private capital mobilised through equity, loans, guarantees, syndication or the Quantum Investment Service Desk is excluded from the central envelope and would be reported separately;
- procurement expenditure is not treated as a benefit, and supplier revenues from procurement contracts are not treated as supplier co-financing;
- programme expenditure is not added mechanically to the administrative, adjustment or societal-cost estimates generated through the Standard Cost Model; and
- the estimate is associated with the delivery of PO2 but does not alter the legal content of the option or determine the option ranking.

19.1. BOTTOM-UP CALIBRATION AND FINANCING STRUCTURE

The estimate is built bottom-up from the portfolio of actions. It reflects updated assumptions concerning scientific excellence, Technology and Innovation Hubs, competence clusters, Grand Challenges, ecosystem R&I, quantum-computing platforms and systems, testing facilities, Strategic Projects, skills and horizontal ecosystem-support measures.

Deployment and first-buyer expenditure is embedded in the relevant computing-system and Strategic Project lines. It is therefore not presented as a separate additional procurement envelope. Similarly, support for dependencies, standards, benchmarking, PQC implementation, strategic intelligence and studies may be financed through the relevant ecosystem R&I and horizontal-support lines and should not be added again as separate budget categories**.**

High-level area	Union contribution	Total resources
Scientific excellence, R&I and technology maturation	EUR 1.0575–1.4575bn	EUR 2.665–3.865bn
Quantum infrastructures and testing	EUR 1.90–2.25bn	EUR 4.60–5.30bn
Pilot infrastructures, Strategic Projects and first deployments	EUR 1.90–2.00bn	EUR 5.20–8.40bn
Skills and horizontal/ecosystem measures	EUR 0.33–0.41bn	EUR 0.43–0.51bn
Total	**EUR 5.1875–6.1175bn**	**EUR 12.895–18.075bn**

Table 4.34 *Summary of indicative PO2 programme-resource planning ranges, 2028–2034. Source: Commission-services bottom-up estimate. Member State and industry amounts are derived from the indicative co-financing assumptions applied to each action and do not constitute confirmed commitments.*

19.2. INDICATIVE ALLOCATION FOR PO2

The allocation below translates the principal measures included in PO2 into an indicative programme-resource structure. It combines measures implemented primarily through Union programmes, measures expected to involve Member State co-financing and actions in which direct industry participation could reasonably be expected.

The bottom-up planning exercise identifies an indicative Union programme contribution of EUR 5.19–6.12 billion for PO2 over 2028–2034. Applying the action-specific resource assumptions underlying the portfolio gives an indicative total direct programme volume of approximately EUR 12.90–18.08 billion, including Union resources and expected Member State and industry participation where relevant. These ranges reflect alternative scales of implementation rather than statistical confidence intervals. They do not imply a uniform co-financing rate or a legal commitment by Member States or industry.

Area/action	Union contribution	Total resources	Planning basis

Scientific excellence, R&I and technology maturation			
Quantum S&T Excellence Network	EUR 87.5m	EUR 175m	Distributed research-excellence cooperation
Technology and Innovation Hubs	EUR 185m	EUR 370m	Specialised engineering, testing and maturation capabilities
Competence and Acceleration Centres	EUR 235m	EUR 470m	Distributed user access, acceleration and referral
Quantum Grand Challenges	EUR 400–700m	EUR 1.2–2.1bn	Scalable according to number and ambition of Challenges
Other ecosystem R&I	EUR 150–250m	EUR 450–750m	Additional maturation and enabling-technology actions
R&I subtotal	**EUR 1.0575–1.4575bn**	**EUR 2.665–3.865bn**	
Quantum infrastructures and testing			
20–27 quantum machines integrated with AI Factories	EUR 1.0–1.35bn	EUR 2.0–2.7bn	Number of systems scalable to available resources
Further development of 6 quantum-computing platforms and 2 simulators	EUR 800m	EUR 2.4bn	Development of existing/prototype European platforms
Testing and experimentation	EUR 100m	EUR 200m	System-level and non-chip-specific capabilities
Infrastructure subtotal	**EUR 1.90–2.25bn**	**EUR 4.60–5.30bn**	
Strategic Projects and first deployments			
EuroQCI	EUR 800m	EUR 1.6bn	Incremental activity; avoid baseline double counting
Quantum Internet	EUR 200m	EUR 400m	Development/deployment
Quantum gravimetry/PNT	EUR 200m	EUR 400m	Strategic sensing and navigation capability
Quantum-enhanced MRI	EUR 200m	EUR 400m	Deployment and scale-up of validated capability
Quantum software	EUR 200m	EUR 600m	Software stacks, middleware, algorithms and applications
Other Strategic Projects	EUR 300–400m	EUR 1.8–5.0bn	Scalable portfolio; €4bn may be used as central internal planning case
Pilot infrastructures and Strategic Projects subtotal	**EUR 1.90–2.00bn**	**EUR 5.20–8.40bn**	
Skills and horizontal/ecosystem measures			
Skills and mobility	EUR 100m	EUR 200m	Industrial, technical, deployment and user-side skills
International cooperation	EUR 150–200m	EUR 150–200m	Strategic partnerships and joint activities
Quantum Business Platform	EUR 30m	EUR 30m	Development and operation
CSAs, studies and programme support	EUR 50–80m	EUR 50–80m	Governance, intelligence, coordination and studies
Horizontal subtotal	**EUR 330–410m**	**EUR 430–510m**	
TOTAL QUANTUM ACT PROGRAMME RESOURCES	**EUR 5.1875–6.1175bn**	**EUR 12.895–18.075bn**	**Excludes broader sector financing needs and Chips JU activities.**

Table 4.35. *Bottom-up programme suggested budget -*

Source: Commission-services bottom-up estimate. The figures indicate possible portfolio composition and do not earmark funds, predetermine project selection or establish a legal obligation on Member States or industry to provide the amounts shown[5].

The number, scale and technological orientation of the individual actions would be determined through roadmaps, competitive selection, maturity and demand assessments and portfolio reviews. In particular:

- the legislation would not predetermine the number or location of competence and user-support nodes;
- the assumptions of up to eight Technology and Innovation Hubs and seven Grand Challenges, comprising one FTQC Grand Challenge and six additional Grand Challenges, are programme-planning assumptions rather than statutory requirements;
- additional infrastructure would be financed only where capability mapping, access data or demand evidence demonstrate a missing capability or persistent capacity constraint;
- support for EuroQCI concerns incremental activity over 2028–2034 and do not duplicate activities already financed under the dynamic baseline;
- the testing and experimentation amount covers system-level and non-chip-specific facilities and does not include quantum-chip or semiconductor pilot-line expenditure;
- any PQC implementation support included within the "Other measures" line concerns technical advice, common tools, testing and implementation coordination attributable to the Quantum Act, not the economy-wide cost of replacing cryptographic assets or complying with existing cybersecurity obligations; and
- the broader sector financing-needs estimate is not included in the programme-resource total and is reported separately below.

19.3. DIRECT INDUSTRY PARTICIPATION AND ADDITIONAL PRIVATE MOBILISATION

The total-resource ranges include action-specific Member State and industry participation where this forms part of the underlying delivery assumption. They should not be interpreted as implying a uniform co-financing rate or confirmed commitments. Direct project-level industry participation is analytically distinct from additional private capital mobilised through financial instruments. The latter is therefore reported separately and is not included in the EUR 12.90–18.08 billion direct programme-resource range.

Direct industry contributions to other actions may arise during implementation but are not included in the central estimate unless a specific co-financing assumption has been identified. Additional private capital mobilised through equity, debt, guarantees or the Quantum Investment Service Desk is reported separately.

19.4. INDICATIVE SECTOR FINANCING NEEDS

Financing need	Indicative amount
20–40 start-ups, up to EUR 100m each	EUR up to 4bn

[5] Figures reflect rounded programme-planning assumptions. Consequently, some formula components may not sum exactly before rounding. The quantum-computing platform, system-acquisition and testing lines cover full systems and non-chip-specific capabilities. Quantum-chip design, fabrication, pilot-line, prototyping, testing and validation expenditure is excluded and remains under the Chips Act and the Chips Joint Undertaking. The number and location of actions are indicative programme assumptions, not requirements established by the Regulation.

Up to 50 scale-ups, Series B/C, EUR 400–500m each	EUR 20–25bn
Large strategic projects and foundries	EUR 25–30bn
Total indicative sector financing need	**Around EUR 50–60bn**

Table 4.36. *Financing need per size of player*

These figures represent indicative sector financing needs, mainly equity, rather than programme expenditure or a funding commitment. They could be addressed through a combination of private investment and instruments such as the EIC, InvestEU, STEF and others. They are separate from the EUR 5.19–6.12 billion Union programme-resource range.

Related Chips JU quantum activities	EU contribution	Total resources
Up to six quantum pilot lines	EUR 300–400m	EUR 900m–1.2bn
Design tools	EUR 50m	EUR 100m
Enabling technologies	EUR 100m	EUR 200m
CSAs/community/studies	EUR 30m	EUR 30m
Subtotal excluding foundries	**EUR 480–580m**	**EUR 1.23–1.53bn**
Quantum foundries	TBD	TBD

Table 4.37. *JU activities expected budget*

These activities are presented for completeness and to clarify the boundary between the Quantum Act planning exercise and the Chips JU. They are not included in the Quantum Act programme-resource totals above. Future quantum-foundry investment remains to be determined, and any use of Union financial instruments should be checked for overlap with the broader sector financing-needs estimate.

19.5. RELATIONSHIP WITH THE POLICY OPTIONS

The programme-resource estimate is presented for PO2 because it is the preferred option and contains the delivery architecture required to coordinate the portfolio, including common programming, Grand Challenges, Strategic Projects, infrastructure access, procurement pathways, finance support and monitoring.

PO1 would rely principally on voluntary cooperation and improved use of existing instruments. No separate programme-resource envelope is estimated for PO1, although ordinary programme expenditure could continue under the dynamic baseline.

PO3 would retain the PO2 delivery architecture but could require additional resources for a dedicated investment mandate or capacity within existing or future financial instruments and higher-intensity strategic procurement. No separate PO3 envelope is quantified because its scale would depend on the final design of those instruments and future budgetary decisions. The absence of a separate PO3 envelope does not imply that its programme-resource requirements would be identical to those of PO2.

The programme-resource estimate does not determine the option ranking. The comparison of PO1, PO2 and PO3 remains based on their effectiveness, efficiency, coherence, proportionality, rights implications and implementation feasibility.

19.6. GOVERNANCE, SELECTION AND REALLOCATION SAFEGUARDS

A portfolio of this scale should be managed as a staged investment programme rather than as a fixed list of projects. The following safeguards would apply:

- publication and periodic updating of technology, infrastructure, demand and dependency roadmaps;
- open, competitive and transparent selection, except where security or duly justified strategic considerations require a restricted procedure consistent with applicable law;
- independent technical, financial and market assessment before major commitments;

- milestones and stage gates for Grand Challenges and Strategic Projects, with later tranches conditional on satisfactory progress;
- additionality tests to establish whether the action would proceed at the same scale and timing without public support;
- technology-neutral selection criteria, except where a roadmap or use case objectively requires a defined capability;
- cross-border participation and European-spillover requirements proportionate to the type of action;
- common and transparent access conditions for publicly supported infrastructures;
- SME and start-up participation measures, including simplified procedures, technical assistance and proportionate reporting;
- monitoring of beneficiary, Member State and industry co-financing;
- portfolio reviews allowing resources to be redirected from underperforming actions, obsolete priorities or facilities with insufficient utilisation;
- monitoring of environmental performance, security, skills, geographic participation and supply-chain effects;
- assessment of whether investments duplicate existing facilities, displace national expenditure already included in the baseline or crowd out viable private financing; and
- explicit controls preventing the same expenditure, output or private investment from being reported under more than one programme category.

Subject to applicable programme and budgetary rules, up to 10% of the portfolio could be reallocated between action categories following a major portfolio review without increasing the total Union envelope.

19.7. MONITORING

Delivery of the programme envelope should be monitored through the framework established in Annex 10. Relevant indicators would include:

- Union resources committed and paid by measure and action category;
- Member State commitments and payments;
- direct beneficiary and industry co-financing;
- additional private capital mobilised through financial instruments, reported separately;
- number and value of Strategic Projects and Grand Challenges selected;
- technical, industrial and deployment milestones achieved;
- projects continued, redirected or discontinued following stage-gate reviews;
- new or upgraded production, testing and infrastructure capacity;
- infrastructure utilisation, waiting times and number of cross-border users;
- SME and start-up participation;
- number and value of PCP, PPI and reference-deployment actions;
- number and diversity of participating public and private buyers;
- prototypes validated and operational deployments achieved;

- follow-on purchases, customer contracts or private investment following reference deployments;
- progress in qualifying alternative suppliers and mitigating identified dependencies;
- people trained, mobility actions and industrial placements completed; and
- contributions to standards, benchmarks, testing methods and assurance arrangements.

Commitments, payments, financial-instrument volumes, direct industry co-financing, additional private mobilisation and physical outputs should be reported separately. They should not be aggregated into a single headline figure without explaining the different financial and economic nature of each category.

19.8. TREATMENT IN THE COST-BENEFIT AND BUDGET ANALYSIS

The bottom-up planning exercise identifies an indicative Union programme contribution of EUR 5.19–6.12 billion and total direct programme resources of EUR 12.90–18.08 billion over 2028–2034, including action-specific Member State and industry participation where relevant. These ranges are presented as a separate programme-resource view and do not replace or alter the administrative, adjustment, public-budget or societal-cost totals produced by the Standard Cost Model. Separately, broader sector financing needs are estimated at around EUR 50–60 billion, mainly equity, comprising approximately EUR 2–4 billion for 20–40 start-ups, EUR 20–25 billion for up to 50 scale-ups, and EUR 25–30 billion for large strategic projects and foundries. These are ceilings on a financing need, not committed or mobilised finance. These needs could be addressed through private investment and instruments such as the EIC, InvestEU, STEF and others. They are reported separately and are not added to the programme-resource total.

The following treatment applies:

- grants, vouchers and similar support are recorded in the public-budget view as transfers and are not automatically treated as societal costs;
- procurement expenditure is a budgetary amount and an activity indicator, not a benefit. Any procurement price premium or incremental resource cost should be assessed separately where evidence permits;
- equity, loans and guarantees are financial instruments. Their face value, public risk-bearing amount and private investment mobilised should be reported separately;
- infrastructure investment should distinguish expenditure, real resource use, existing assets reused and any transfer component;
- Member State and direct industry participation is included in the total programme-resource range only where it represents a separately identifiable contribution to the supported activity;
- supplier revenue from a public procurement contract is not simultaneously counted as private co-investment;
- follow-on private investment should not be added where it is already included within the financing volumes attributed to the Quantum Investment Service Desk; and
- the EUR 12.90–18.08 billion total direct programme-resource range must not be added mechanically to the PO2 societal-cost estimate or to the financing and investment activity indicators produced by the Standard Cost Model.

19.9. UNCERTAINTY AND LIMITATIONS

The programme-resource planning range is subject to substantial uncertainty. The final cost of actions will depend on technological progress, project scale, location, infrastructure requirements, procurement design, participation by Member States and industry, applicable aid intensities and the outcome of the future Multiannual Financial Framework.

The estimated Member State and industry contributions are leverage assumptions rather than confirmed commitments. They should be validated through consultation with the relevant programme authorities, implementing bodies, Member States, infrastructure operators and industry before final budgetary decisions.

The estimate does not quantify:

- a dedicated capital envelope for the Quantum Investment Service Desk;
- all private capital that could be mobilised through financial instruments;
- wider company investment triggered by improved market expectations;
- follow-on commercial investment after successful procurement or reference deployment;
- expenditure financed entirely under the dynamic baseline; or
- economy-wide PQC migration and replacement costs attributable to existing cybersecurity frameworks.

The estimates should therefore be interpreted as a transparent bottom-up planning reference for PO2, not as a forecast of actual expenditure or total investment generated by the initiative.

ANNEX 5: COMPETITIVENESS CHECK

20. OVERVIEW OF IMPACTS ON COMPETITIVENESS

Dimensions of Competitiveness	Impact of the initiative (++ / + / 0 / - / -- / n.a.)	References to sub-sections of the main report or annexes
Cost and price competitiveness	+	Main Report, Section 6.3; Annex 3; Annex 4; Annex 8
International competitiveness	++	Main Report, Sections 2.1 and 6.3; Annex 8
Capacity to innovate	++	Main Report, Section 6.3; Annex 8
SME competitiveness	+	Main Report, Section 6.3; Annex 6

Table 5.1. Overview of impacts on competitiveness

21. SYNTHETIC ASSESSMENT

PO2 is expected to have an **overall positive impact on the competitiveness of the EU quantum sector**, mainly by improving the transition from research and start-up creation to industrial validation, scale-up and deployment. This responds to a clear competitiveness gap (for more details, see Section 2 of the Impact Assessment and Annex 6: SME check). Cost and price competitiveness is assessed as **moderately positive**, with **EUR 8.83 million NPV in business costs** compared with **EUR 6.45 million in modelled savings**, excluding wider benefits not captured by the model. International competitiveness and innovation capacity are assessed as **strongly positive**, while SME competitiveness is **moderately positive**, provided that administrative burdens and access barriers are effectively mitigated.

22. COMPETITIVE POSITION OF THE MOST AFFECTED SECTORS

The initiative primarily affects the emerging European quantum-technology ecosystem and its specialised enabling supply chains, including quantum computing and simulation, quantum communication, quantum sensing and metrology, software, components and related enabling technologies.

Available company mapping identifies 141 EU-based quantum companies in a global sample of 441 companies. The European ecosystem is characterised by a large number of young and relatively small firms: around 60% of mapped EU quantum firms were established after 2018, and only around 7.6% of firms for which employment data are available have more than 100 employees.

At the same time, the evidence points to weaker progression towards later-stage financing and industrial scale. Mapped EU quantum firms attracted approximately EUR 862 million in venture-capital investment between 2012 and 2024, compared with approximately EUR 2.9 billion for US firms. The EU therefore combines a strong scientific and entrepreneurial base with a comparatively weaker capacity to finance and scale companies through later stages of industrial development.

The preferred option is expected to strengthen the competitive position of the affected sectors by improving access to shared infrastructure, scale-up finance, first buyers, testing and standards, skills and cross-border industrial cooperation. The magnitude of these effects remains uncertain and will depend on technological maturity, market uptake and the implementation of accompanying Union and Member State programmes.

ANNEX 6: SME CHECK

23. OVERVIEW OF IMPACTS ON SMEs

The initiative is considered highly relevant for SMEs. European quantum companies are predominantly young and relatively small. SMEs and start-ups are therefore central to the expected benefits and may also be disproportionately affected by fixed application, reporting, testing, qualification and procurement costs.

SME Check	Assessment
(1) IDENTIFICATION OF AFFECTED BUSINESSES AND ASSESSMENT OF RELEVANCE	
Are SMEs directly affected? (Yes/No) In which sectors?	Yes. SMEs are directly affected in quantum hardware, software and applications, components and enabling technologies, cybersecurity/PQC, specialised engineering, testing and related technical services.
Estimated number of directly affected SMEs	A robust EU-wide estimate by SME size is not available because quantum technologies do not correspond to a single statistical business category and SME status is incomplete in the available datasets. The mapping identifies 141 EU-based quantum companies out of 441 mapped globally and indicates that the ecosystem is predominantly composed of young and relatively small firms.
Estimated number of employees in directly affected SMEs	A robust EU-wide estimate is not available because employment coverage and SME status are incomplete across the available company datasets.
Are SMEs indirectly affected? (Yes/No) In which sectors? What is the estimated number of indirectly affected SMEs and employees?	Yes. SMEs may be indirectly affected as suppliers, subcontractors, consortium partners, infrastructure users and adopters of quantum technologies. A reliable EU-wide estimate of indirectly affected SMEs and employees is not available.
(2) CONSULTATION OF SME STAKEHOLDERS	
How has the input from the SME community been taken into consideration?	SMEs participated in the Call for Evidence, targeted interviews and industry survey. Of 41 industry-survey respondents, 33 were micro, small or medium-sized organisations: 12 micro, 14 small and 7 medium-sized. Their input informed the design of measures on infrastructure access, finance, procurement, standards, reporting and simplification.
Are SMEs' views different from those of large businesses? (Yes/No)	Yes, to some extent. SMEs placed greater emphasis on affordable infrastructure access, later-stage finance, first customers, simplified procedures and the disproportionate impact of fixed testing, qualification and reporting costs. The number of large-company respondents was too small for a robust quantitative comparison.
(3) ASSESSMENT OF IMPACTS ON SMEs	
What are the estimated direct costs for SMEs of the preferred policy option? – Qualitative assessment	Costs may arise from applications, project monitoring, testing and qualification, procurement participation and narrowly targeted information requests. Most business participation remains voluntary.
Quantitative assessment	The model does not permit a robust allocation of costs by company size. For businesses/private actors as a whole, PO2 entails EUR 8.83 million NPV, including EUR 5.50 million NPV of administrative costs (EUR 5.46 million within One-In, One-Out). These figures should not be interpreted as SME-specific costs.
What are the estimated direct benefits/cost savings for SMEs of the preferred policy option? – Qualitative assessment	SMEs are expected to benefit from improved access to specialised infrastructure, finance and investors, procurement and reference customers, testing and standards support, skills and user-support services.
Quantitative assessment	Modelled savings for businesses and private actors as a whole amount to EUR 6.45 million NPV under PO2. The available data do not allow these savings to be allocated reliably between SMEs and larger businesses.
What are the indirect impacts of this initiative on SMEs?	Expected positive impacts include stronger supply chains, improved market opportunities, greater investor and customer confidence and

	better access to cross-border ecosystems. Potential negative impacts include concentration of support, incumbent advantage, skills shortages and fixed testing, qualification and reporting costs.
(4) MINIMISING NEGATIVE IMPACTS ON SMEs	
Are SMEs disproportionately affected compared to large companies? (Yes/No) If yes, are there any specific subgroups of SMEs more exposed than others?	Potentially yes. Fixed application, reporting, testing and qualification costs can represent a higher relative burden for micro and small enterprises, in particular firms with limited administrative capacity.
Have mitigating measures been included in the preferred option/proposal? (Yes/No)	Yes. Measures include simplified and staged applications, common templates, digital processes, once-only information reuse, proportionate requirements, technical assistance, shared testing and vouchers, staged procurement and cross-border infrastructure access. Targeted information requests are limited by necessity and proportionality.
CONTRIBUTION TO THE 35% BURDEN REDUCTION TARGET FOR SMEs	
Are there any administrative cost savings relevant for the 35% burden reduction target for SMEs?	No quantified contribution is claimed. Although the model identifies EUR 6.45 million NPV of business-side savings, these cannot currently be allocated reliably to SMEs and do not necessarily constitute qualifying administrative OUTs. Annex 3 therefore reports EUR 0 of qualifying administrative OUTs.

Table 6.1. Impacts on SMEs

The classification as highly relevant should be reflected in the Inter-Service Group conclusions, the executive summary, the Main Report and the monitoring framework.

ADDITIONAL INFORMATION

24. IDENTIFICATION OF AFFECTED SMES

24.0. SME POPULATION AND CHARACTERISTICS

The quantum sector does not correspond to a single statistical business category. Quantum firms operate across research and development, specialized electronics, photonics, semiconductors, software, cybersecurity, telecommunications, sensing, aerospace and professional services. Standard structural-business datasets therefore do not provide a complete count of quantum SMEs by size. The available mappings nevertheless indicate that the EU has a comparatively large and young entrepreneurial base:

- 141 of 441 mapped global quantum companies were EU-based;
- approximately 60% of the mapped EU firms were established after 2018;
- only approximately 7.6% of EU firms with available employment data exceeded 100 employees;
- EU firms participated in 18 of 95 identified financing rounds above EUR 25 million; and
- EU quantum firms raised approximately EUR 862 million in venture capital between 2012 and 2024, compared with EUR 2.9 billion raised by US firms.

These figures use different datasets and should not be combined arithmetically. Taken together, they indicate that most EU quantum companies are at start-up or early growth stage and that comparatively few have reached substantial industrial scale.

24.1. PRINCIPAL SME GROUPS AFFECTED

SME group	Typical role	Principal policy measures

Quantum hardware developers	Computing, communication or sensing systems and subsystems	PM2 Quantum S&T Excellence Network; PM3 Quantum Grand Challenges; PM4 Technology and Innovation Hubs; PM5 Strategic Quantum Infrastructuress and Strategic Quantum Projects; PM7 innovation procurement; PM8 standards, benchmarking and assurance; PM9 skills and mobility; PM10 Quantum Investment Service Desk;
Quantum software and application firms	Algorithms, middleware, control, integration and sectoral applications	PM2–PM3 research; PM5 Strategic Quantum Infrastructuress and Strategic Quantum Projects; PM6 Competence and Acceleration Centres; PM7 procurement; PM8 standards; PM9 skills; PM10 Quantum Investment Service Desk; PM12 Quantum Business Platform
Component and enabling-technology suppliers	Photonics, electronics, cryogenics, materials, packaging, testing and specialist equipment	PM4 Technology and Innovation hubs; PM5 Strategic Quantum Infrastructuress and Strategic Quantum Projects; PM7 procurement; PM8 standards; PM10 Quantum Investment Service Desk; PM11 strategic intelligence and dependency monitoring; PM14 strategic international cooperation
Cybersecurity and PQC providers	Cryptographic products, migration tools, testing and integration	PM6 Competence and Acceleration Centres; PM7 procurement; PM8 standards; PM9 skills; PM13 quantum-safe preparedness
Specialised engineering and service firms	Testing, integration, consultancy, training, metrology and user support	PM4 Technology and Innovation hubs; PM6 Competence and Acceleration Centres; PM7 procurement; PM8 standards; PM9 skills; PM12 Quantum Business Platform
SME users and adopters	Industrial or service-sector firms experimenting with or procuring quantum solutions	PM4 Technology and Innovation hubs; PM6 Competence and Acceleration Centres; PM7 procurement; PM8 standards; PM9 skills; PM12 Business Platform; PM13 quantum-safe preparedness
SME infrastructure operators or RTO-linked entities	Access, testing, qualification and technical services	PM2–PM4 research and access; PM5 Strategic Quantum Infrastructuress and Strategic Quantum Projects; PM6 Competence and Acceleration Centres; PM8 standards; PM9 skills; PM11 strategic intelligence

Table 6.2. *Principal SME groups affected under the final PM1–PM16 architecture.*

SMEs are not affected uniformly. Hardware and component firms are generally more capital-intensive and depend more heavily on specialised facilities. Software and service firms may face lower physical-infrastructure requirements but depend strongly on hardware access, user demand and interoperability. PQC providers may operate in more mature markets but interact with existing cybersecurity requirements and assurance schemes. SME users may benefit from support in identifying viable use cases but may lack the expertise and resources required for early adoption.

25. DIRECT AND INDIRECT SCOPE

SMEs may be directly affected where they:

- apply for infrastructure access, a voucher, grant, finance or procurement opportunity;
- participate in a European Quantum Science and Technology Excellence Network activity, Grand Challenge or Strategic Project;
- receive user-support or skills services;
- provide proportionate monitoring information as a condition of support;
- test products against common benchmarks or assurance requirements;
- participate voluntarily in standards, matchmaking or investment-readiness activities; or
- receive a targeted information request because they operate in a clearly defined critical category.

SMEs may be indirectly affected as suppliers, consortium partners, subcontractors, users or competitors of supported firms. The initiative does not impose general obligations on all SMEs or on businesses unrelated to quantum technologies.

26. CONSULTATION OF SME STAKEHOLDERS

SMEs and start-ups were covered through the Call for Evidence, targeted interviews, the PPMI/d-fine industry survey and exchanges with industry associations. The industry survey provides the clearest size breakdown.

Organization size	Responses	Share of total
Micro, 1–9 employees	12	29%
Small, 10–49 employees	14	34%
Medium, 50–250 employees	7	17%
Large, 250–999 employees	4	10%
Very large or global enterprise	3	7%
Other	1	2%
Total	41	100%

Table 6.3. *Industry-survey respondents by size.*

Approximately 80% of survey respondents were micro, small or medium-sized organisations. The consultation was not statistically representative, and the number of larger-company responses was too small to support robust quantitative comparison between size classes. It nevertheless identified consistent differences in administrative capacity, financing needs and exposure to fixed testing and qualification costs.

SME concern	Design response under PO2
Difficulty identifying and accessing suitable infrastructure	PM4 common access arrangements and PM6 user-support Centres; transparent service information, referral and SME-oriented support
High cost of specialised equipment and expertise	Shared facilities, vouchers, technical assistance and targeted adaptation of existing centres
Later-stage financing gap	Quantum Investment Service Desk combining a structured investment pipeline, investment-readiness support, access to appropriate financial products and case-by-case strategic-capability support through existing or future instruments.
Lack of reference customers	PM7 buyer coordination, PCP/PPI, staged procurement and reference deployments
Complex applications and fragmented reporting	Common templates, digital processes, staged applications and once-only information reuse across the package
Fixed testing and assurance costs	PM8 common benchmarks, shared testing and reusable results; no horizontal compulsory certification under PO2
Difficulty participating in standards	Support for SME participation in pre-standardisation, standards and testing activities
Concern about recurring supply-chain reporting	PM11 risk-based, scoped information requests limited to necessary information unavailable elsewhere
Risk of incumbent advantage	Open selection, stage gates, appropriate lotting, multi-supplier approaches and monitoring of beneficiary concentration
Geographic concentration of facilities	Distributed PM6 user-support Centres and cross-border access under PM4

Table 6.4. *How SME input influenced the preferred option.*

27. ASSESSMENT OF IMPACTS ON SMES

27.0. DIRECT BENEFITS

Infrastructure access and user support. PM4 and PM6 should reduce search, navigation and negotiation costs and improve access to shared fabrication, testing, metrology, integration and qualification capabilities. The illustrative scenario indicates that, if 40–120 projects obtain access or qualification one to two months earlier, approximately 40–240 project-months of development could be brought forward annually. The available evidence does not permit a reliable SME-specific allocation.

Research, Grand Challenges, Advanced/Pilot Infrastructures and Strategic Projects. PM2, PM3 and PM5 can give SMEs access to cross-border consortia, milestone-based development pathways, specialist capabilities and stronger project visibility. Designation must not create an automatic funding entitlement or exclude non-designated SMEs from other support.

Finance. PM10 would establish a Quantum Investment Service Desk helping quantum SMEs and scale-ups improve investment readiness and access relevant Union, national and private financing opportunities. It would facilitate referrals and coordination among financing actors without making individual financing decisions. PO3 would involve a separate dedicated financing mandate or capacity.

Demand and procurement. PM7 can provide SMEs with early revenues, operational validation, reference customers, user feedback and stronger evidence for investors. The procurement scenario indicates that EUR 100 million of well-designed innovation procurement could be associated with approximately EUR 25–50 million in persistent supplier revenue and EUR 10–20 million in additional private investment. These coefficients are illustrative and not quantum-specific forecasts.

Standards and trusted deployment. PM8 should reduce repeated testing and buyer uncertainty through common terminology, benchmarks, test methods and interoperability profiles. SMEs may benefit particularly because they have less capacity than large firms to negotiate bespoke technical requirements with each customer.

Skills and user capability. PM9 should improve access to engineering, software, integration, cybersecurity, procurement, product-development and commercialisation capabilities.

Strategic intelligence, matchmaking and international cooperation. PM11, PM12 and PM14 can improve visibility of supply-chain opportunities, users, investors, partners and emerging risks, subject to confidentiality, data minimisation and separation between voluntary commercial functions and regulatory information requests.

27.1. QUANTIFIED BUSINESS-FACING COSTS AND SAVINGS

The model reports costs for businesses and other private actors as a whole. It does not provide a reliable allocation between micro, small, medium-sized and large firms. The values below must therefore not be presented as SME-specific costs.

Business/private-actor result, EUR million NPV	PO1	PO2	PO3
Total costs	2.77	8.83	26.94
Modelled savings	2.07	6.45	6.70
Net modelled business cost	0.70	2.38	20.24
Of total costs: administrative costs	0.00	5.50	16.41
Of total costs: administrative costs within One-In, One-Out	0.00	5.46	16.28
Of total costs: adjustment costs	0.00	0.00	7.20
Of total costs: participation without a legal requirement (not a compliance cost)	2.77	3.33	3.33

Table 6.5. *Business-facing costs and modelled business savings. Values are not SME-specific.*

Under PO2, the directly modelled net business cost is modest: EUR 8.83 million NPV of business and private-actor costs is set against EUR 6.45 million of modelled business-side savings, leaving a net directly modelled cost of EUR 2.38 million. This does not include wider benefits from improved infrastructure access, finance, firm survival or growth.

The PO2 business costs comprise EUR 5.50 million NPV of administrative costs, of which EUR 5.46 million fall within One-In, One-Out (including EUR 1.23 million of evidence on PQC requirements in public procurement), and EUR 3.33 million of time that firms choose

to spend in the new structures without a legal requirement, which is not a compliance cost[6]. No business adjustment costs are modelled under PO2. The PO3 figures are materially higher because the option introduces wider dependency reporting, binding PQC-preparedness duties for defined critical entities (business adjustment costs of EUR 7.20 million) and more intensive procurement conditions.

Under PO3, targeted binding PQC-preparedness duties could also affect SMEs that fall within the defined critical-actor population. The model does not assume that all quantum or cybersecurity SMEs would be covered. Scope thresholds, technical assistance, phased implementation, reuse of existing documentation and proportionate reporting would be necessary to avoid disproportionate fixed costs.

27.2. PRINCIPAL SME-FACING ACTIVITIES

Activity	Likely frequency	Indicative burden	Nature
User-support orientation or initial infrastructure request	Per request	Low	Voluntary
Application for infrastructure support or a voucher	Per application	Low–moderate	Voluntary
Grand Challenge or project application	Per application	Moderate	Voluntary
Strategic Project application	Per application	Moderate–high	Voluntary
Reporting for a supported project or facility	Normally annual or milestone-based	Moderate	Condition of support
Procurement participation	Per procedure	Moderate–high	Voluntary
Evidence of compliance with PQC requirements in public procurement	Per procedure where the requirements apply	Low	Condition of taking part in the procedure
Standards, benchmarking or testing participation	Activity-dependent	Moderate	Normally voluntary
Targeted strategic-intelligence request	Risk-based, not routine	Low–moderate; potentially higher in complex cases	Mandatory only where a legal basis applies

Table 6.6. *Indicative SME-facing activities. Detailed assumptions are provided in Annex 4 .*

27.3. INDIRECT IMPACTS

Expected positive indirect impacts include:

- stronger investor and customer confidence;
- growth of European supplier networks and cross-border consortia;
- improved visibility of commercial and procurement opportunities;
- reduced risk of project disruption and technical lock-in;
- improved access to large industrial and public users; and
- greater capacity to retain intellectual property, employment and industrial activity in the Union.

Potential negative indirect impacts include:

- concentration of support among firms already connected to established clusters;
- advantage for incumbents able to co-finance or manage complex applications;
- procurement or assurance requirements favouring established technologies;
- exclusive or proprietary infrastructure arrangements;

[6] Administrative costs comprise information obligations attached to Union funding, Strategic Project designation, supported procurement, PQC requirements in public procurement and targeted requests (EUR 4.78 million NPV) and the requirements for taking part in regulatory sandboxes, the business platform and investment support (EUR 0.72 million); documentation for investment support (EUR 0.05 million) is not offset under One-In, One-Out (Tool #58, Box 4). Displayed components are rounded; total business/private-actor costs are EUR 8.83 million NPV.

- increased competition for scarce skills;
- requirements being applied before smaller firms or technologies are sufficiently mature; and
- possible disclosure of commercially sensitive supplier information.

28. DISPROPORTIONATE IMPACTS AND MITIGATING MEASURES

Fixed regulatory and administrative costs generally affect smaller firms more strongly because they are spread over fewer employees and lower revenues and because SMEs have fewer dedicated legal, regulatory and public-affairs resources. A general SME exemption would not be appropriate: most participation is voluntary, while a blanket exemption could create a material evidence gap where a micro or small company is the sole supplier of a critical component. The preferred approach is proportionality by design.

Potential disproportionate effect	Mitigating measure
Fixed application costs	Short standard forms, staged applications and reuse of company information
Difficulty navigating programmes and facilities	Common digital interface and personalised support through PM6 Competence and Acceleration Centres
Limited capacity to prepare technical proposals	Technical assistance, brokerage and consortium-building support
Cost of facility access	Vouchers, transparent pricing and proportionate co-financing
High reporting burden	Minimum necessary indicators, once-only submission and consolidated reporting
Standards and testing costs	Supported participation, shared testing, reusable results and no general compulsory certification under PO2
Procurement favouring large firms	Staged PCP/PPI, appropriate lotting, consortia and functional specifications
Cash-flow pressure	Proportionate pre-financing and payment schedules under the relevant programme rules
Requirements introduced before maturity	Phased implementation, maturity tests and review clauses
Strategic-intelligence requests	Risk-based scope, data minimisation, confidentiality safeguards and adjusted deadlines
Difficulty proving SME status	Use only the SME-definition criteria necessary for the measure and avoid repeated verification
Geographic concentration of benefits	Cross-border access, widening outreach and monitoring by Member State, region and firm size

Table 6.7. *SME mitigating measures.*

Commission Recommendation 2003/361/EC and any successor definition should be used only where an SME-specific measure requires it. Repeated proof of SME status should be avoided because application of the definition itself creates administrative cost.

29. MONITORING OF SME IMPACTS

Because the initiative is highly relevant for SMEs, the monitoring framework should include SME-specific indicators collected through existing programme and administrative systems wherever possible.

Dimension	Indicator
Participation	Number and share of micro, small and medium-sized applicants, users and beneficiaries
Access	SME access requests, approval rates, waiting times and cross-border use
Finance	Finance committed to SMEs; private leverage; follow-on rounds and cross-border syndication
Procurement	SME participation and success in PCP/PPI; pilots progressing to reference deployment or repeat procurement
Burden	Application and reporting staff time by firm size; duplicate requests avoided

Standards	SME participation in standards, benchmarking and testing; use of supported testing
Growth	Supported firms reaching employment, revenue, investment or market-entry milestones
Competition	Beneficiary and supplier concentration; participation of new entrants
Geography	SME beneficiaries and users by Member State and region
Resilience	Number of SME suppliers receiving targeted requests and average response burden

Table 6.8.*SME monitoring indicators.*

Indicators should be disaggregated by company size without creating a new recurring reporting system. Data already available through calls, procurement, finance, infrastructure-access and programme-monitoring systems should be reused.

30. ONE-IN, ONE-OUT AND THE SME BURDEN-REDUCTION TARGET

Under PO2, new business administrative burdens within the scope of One-In, One-Out are estimated at EUR 5.46 million NPV, equivalent to approximately EUR 0.621 million per year across the affected business population. The estimate cannot currently be allocated reliably between SMEs and larger businesses.

The model identifies EUR 6.45 million NPV of modelled savings accruing to businesses. These are economic benefits but are not automatically treated as formal One-In, One-Out offsets because they do not necessarily result from the repeal or simplification of an existing Union information obligation. No amount should therefore be reported as a contribution to the SME burden-reduction target unless the final legal obligations and monitoring data distinguish qualifying administrative INs and OUTs by company size.

31. OVERALL CONCLUSION

The preferred option is expected to have a positive overall effect on SMEs because its main economic measures address the constraints faced by young and smaller quantum firms: access to specialised facilities, growth finance, first customers, technical and user skills, standards support and trusted deployment pathways.

SMEs may nevertheless face proportionately greater fixed application, reporting, testing and qualification costs than larger firms. The positive assessment therefore depends on effective implementation of simplified procedures, technical assistance, once-only reporting, proportionate information requests, maturity-sensitive requirements, open infrastructure access and contestable procurement.

A blanket SME exemption is neither necessary nor appropriate. Most business participation is voluntary, while narrowly defined obligations may be necessary where a small firm performs a critical supply-chain role. Proportionality by size, activity, risk and administrative capacity provides the more effective safeguard.

ANNEX 7: KEY TECHNICAL CONCEPTS

Quantum technologies (QT) exploit quantum-mechanical effects (notably superposition, entanglement and quantum measurement[7]) to enable capabilities that are difficult or impossible to achieve with classical technologies. In policy terms, quantum technologies are usually grouped into three pillars: quantum computing and simulation, quantum communication, and quantum sensing. While these pillars share scientific foundations, they have different industrial value chains, maturity profiles, infrastructure needs, and standardisation/trust requirements. This annex clarifies the key technical concepts needed to understand the intervention logic, the measures and the impacts assessed in this impact assessment.

In simplified terms, **superposition** allows a quantum system to be described by a combination of several possible states until it is measured, while **entanglement** creates correlations between quantum systems that cannot be reproduced by classical systems. Together with quantum measurement and other quantum effects, these properties underpin the capabilities exploited by quantum technologies.

32. QUANTUM TECHNOLOGIES AND THEIR VALUE CHAINS

Quantum technologies do not form a single, linear value chain. They comprise several overlapping ecosystems covering quantum computing and simulation, quantum communication, and quantum sensing and metrology. These ecosystems use different physical platforms, components and infrastructures, but share important enabling technologies, including advanced semiconductors, photonics, lasers, cryogenics, vacuum systems, control electronics, specialised materials, software, classical computing and metrology. The same supplier, facility or technical capability may therefore support more than one quantum pillar.

For the purposes of this impact assessment, a quantum-technology value chain covers the progression from scientific knowledge and enabling inputs to integrated systems, deployment and operational use. It includes the following functional layers:

Value-chain layer	Typical activities and inputs	Principal policy relevance
Research and technology development	Fundamental and applied research; development of qubit, photon, atomic, material and device concepts; algorithms and protocols	Scientific excellence, common priorities, intellectual property, researcher mobility and progression towards higher technological maturity
Enabling components and fabrication	Semiconductor and photonic devices, specialised materials, lasers, detectors, cryogenic and vacuum equipment, control and readout electronics, timing and frequency components	Access to fabrication and pilot-line capacity, supplier concentration, production scale, qualification and critical dependencies
Subsystem and system integration	Integration of quantum devices with control systems, packaging, classical computing, communications equipment, power and thermal-management systems	Engineering capability, interoperability, systems integration, access to testbeds and progression from laboratory prototypes to deployable systems
Software, control and service layers	Firmware, control software, compilers, middleware, algorithms, orchestration platforms, network-management tools, cloud or HPC integration and application software	Hardware–software integration, portability, access to systems, user capability, cybersecurity and development of commercial services

[7] In simplified terms, superposition allows a quantum system to be described by several possible states until it is measured, while entanglement creates correlations between quantum systems that cannot be reproduced by classical systems.

Testing, measurement and qualification	Metrology, calibration, performance benchmarking, reliability and environmental testing, interoperability testing, security evaluation and conformity assessment where appropriate	Comparable performance claims, trusted deployment, procurement readiness, supplier substitution and avoidance of premature technological lock-in
Deployment, operation and market uptake	Installation, integration into user environments, procurement, maintenance, upgrades, training, customer support and application development	First buyers, reference deployments, user skills, operational evidence, repeat demand and financing continuity

Table 7.1. *Quantum value-chain functional layers*

This representation is functional rather than institutional. A company or research organisation may operate at several layers, while some functions may be performed through shared facilities or partnerships. The boundaries also evolve as technologies mature. For example, an activity conducted within a research infrastructure may later become a commercial testing or manufacturing service. Conversely, an apparently mature component may still require substantial redesign or qualification when integrated into a different quantum platform.

The value chains are also highly international and technically interdependent. System developers may have visibility over their direct suppliers but less information on the origin, concentration, production capacity and substitutability of upstream sub-components, materials, software or specialised services. A dependency is therefore not established merely because an input is sourced outside the Union. Strategic concern arises where external sourcing is combined with supplier concentration, limited substitutability, long lead times, difficult redesign or requalification, foreign control, or risks affecting secure and continuous operation.

The three pillars have different maturity profiles and bottlenecks. Quantum-computing value chains place particular emphasis on QPU fabrication, control, cryogenic or optical systems, software and integration with classical computing. Quantum-communication value chains depend strongly on photonic components, sources, detectors, network equipment and interoperability and security arrangements. Quantum-sensing and metrology value chains include a wide variety of atomic, photonic, solid-state and precision-measurement platforms, often requiring application-specific integration and qualification. These differences mean that infrastructure, standards, assurance and market-support measures should be adapted to the relevant technology and maturity rather than applied uniformly across the sector.

For the intervention logic, the value-chain perspective helps identify where discontinuities occur between research and engineering; between components and integrated systems; between prototypes and qualified products; between early public support and scale-up finance; and between pilot deployment and repeat demand. It also explains why isolated measures are unlikely to be sufficient. Research, industrialisation infrastructure, finance, procurement, skills, standards and dependency monitoring must operate as connected but non-automatic pathways, while preserving competition, technological neutrality and the responsibilities of the competent programmes and authorities.

33. QUANTUM COMPUTING AND SIMULATION

A quantum computer processes information using qubits, which can represent combinations of 0 and 1 and can be entangled with each other. A quantum computing system is not a single device, but a stack of tightly coupled subsystems: the QPU (quantum processing unit), the control electronics (microwave/laser control and readout), the cryogenic and vacuum infrastructure (for certain platforms), classical compute for orchestration, and a software toolchain for compiling and running quantum programs. The performance of a quantum system is not adequately described by a single metric (e.g., “number of qubits”); what

matters is the ability to execute circuits reliably, which depends on error rates, connectivity, stability, and the classical control environment.

In the near term ("NISQ" era), quantum computing is expected to deliver value in selected domains through hybrid workflows, where classical HPC/cloud systems handle data preparation and optimisation loops while the QPU is used for specific quantum subroutines. Over the longer term, fault-tolerant quantum computing aims to run complex algorithms reliably using quantum error correction, but requires substantial advances in hardware stability, fabrication, control and systems engineering.

34. QUANTUM COMMUNICATION

Quantum communication includes technologies that use quantum states to transmit information or enable security properties. The most mature application today is quantum key distribution (QKD), which enables detection of eavesdropping under defined assumptions, and is often discussed alongside post-quantum cryptography (PQC), which is classical cryptography designed to resist attacks from future quantum computers. Quantum communication systems rely on components such as photon sources, detectors, timing/synchronisation, optics, and networking integration, and require interoperability and trust frameworks to support deployment in critical contexts.

The assessment distinguishes the technical PQC transition already expected under the coordinated roadmap and sectoral cybersecurity frameworks from the incremental effects of the Quantum Act options. PO1 adds no PQC-specific measure beyond the dynamic baseline. PO2 provides for a biennial EU preparedness assessment based on information from Member States and Union entities, coordinated exercises and PQC requirements in public procurement, and establishes structured cooperation on PQC between the Commission, Member States and relevant bodies to coordinate implementation and monitor progress under the existing PQC roadmap. PO3 additionally tests binding implementation of the existing PQC roadmap through time-bound migration requirements. These duties would not replace applicable PQC standards or create a parallel cybersecurity regime.

35. QUANTUM SENSING

Quantum sensing uses quantum effects to achieve higher precision or sensitivity in measurement (time, gravity, inertial, magnetic/electric fields, etc.). Unlike quantum computing, many sensing technologies can reach application readiness earlier, but still face scale-up challenges linked to manufacturing reproducibility, calibration, metrology, and certification for regulated environments.

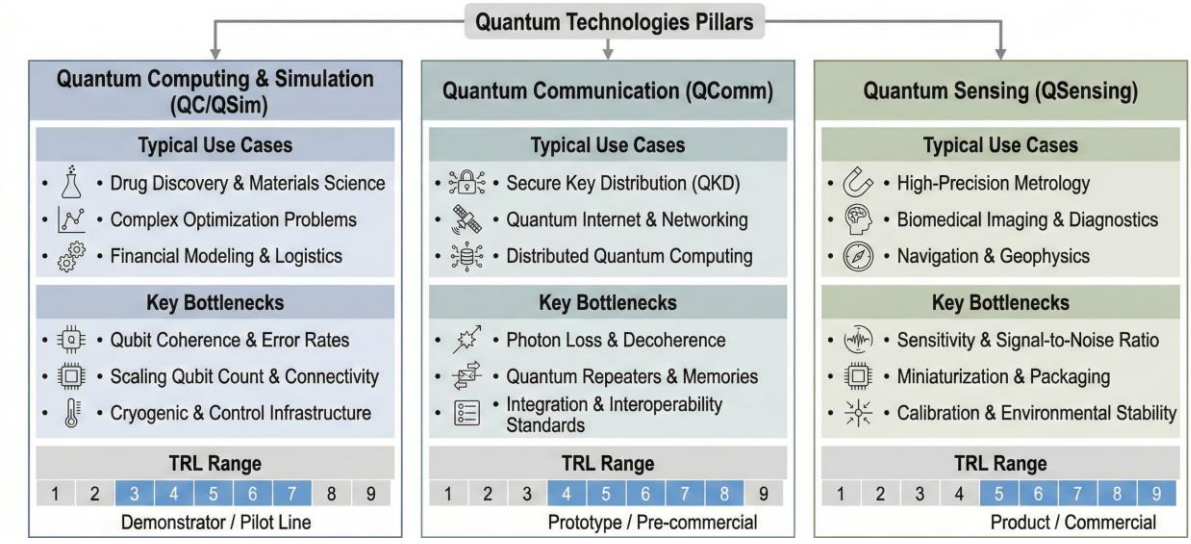

Figure 7.1. *Quantum technologies landscape. Three pillars (QC/QSim, QComm, QSensing) with typical use cases, dominant bottlenecks, and maturity bands*

36. THE QUANTUM COMPUTING STACK AND WHAT "CAPACITY" MEANS

36.0. HARDWARE PLATFORMS AND SYSTEM COMPONENTS

Qubits can be realised using different physical platforms (e.g., superconducting circuits, trapped ions, neutral atoms, photonics, spin-based systems). Each platform has its own supply chain and manufacturing constraints, but most systems require:

- a QPU with qubits and couplers/interconnects
- control and readout electronics (often high-frequency)
- cryogenics/vacuum/laser infrastructure depending on the platform
- classical compute for control loops and data processing
- system integration and packaging

This means that "industrialisation" is not only a matter of producing qubits, but of producing repeatable full systems with predictable performance and maintainability.

36.1. PERFORMANCE METRICS AND WHY THEY ARE MULTI-DIMENSIONAL

Commonly cited metrics include qubit count, gate fidelity, coherence times, circuit depth, connectivity, uptime, and calibration stability. For policy purposes, a useful way to communicate "capacity" is to distinguish:

- physical capability (raw hardware scale and stability)
- usable capability (how reliably useful circuits can be executed)
- application readiness (availability of toolchains, benchmarks, and user support for real tasks)

Because no single metric captures these dimensions, benchmarking needs to be contextual (by platform and use case) and should avoid simplistic comparisons.

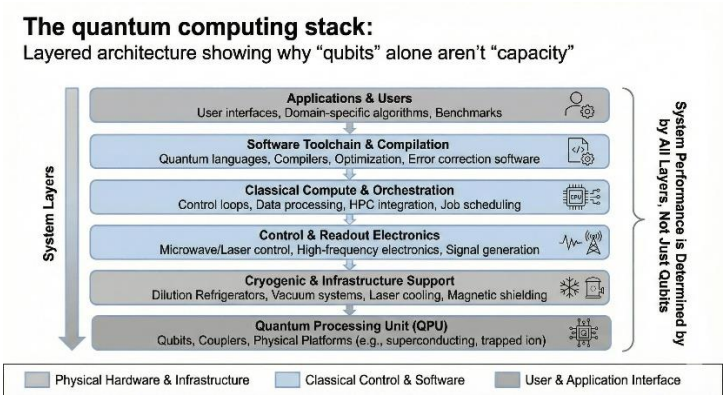

Figure 7.2. *The quantum computing stack.*

37. FROM LAB TO FAB: MATURITY, PILOT LINES, QUALIFICATION AND "STAGE-GATES"

37.0. WHY THE LAB-TO-FAB GAP IS STRUCTURAL

Quantum technologies often face discontinuities between early R&I and industrial deployment because scaling requires reproducible fabrication, packaging, calibration workflows, quality control, component supply stability, and trained engineering teams. Even when prototypes work in a lab environment, industrial contexts require repeatability, serviceability, and predictable performance.

37.1. PILOT LINES, METROLOGY AND QUALIFICATION

Pilot lines are pre-production environments that establish repeatable processes and produce small volumes with quality control. For quantum, pilot-line capacity often needs to be complemented by metrology and qualification capabilities: measurement, calibration, and testing protocols that allow claims about performance and interoperability to be trusted across sites and sectors. These elements are central to the Act's logic on scaling capacity and enabling trusted deployment.

37.2. STAGE-GATES (TRL CONTINUITY)

A stage-gate approach is a milestone-based method to ensure continuity across TRL steps (from research to demonstrators to early industrialisation). For quantum, stage-gates can include agreed evidence packs (benchmarks, stability tests, integration readiness), reducing the risk of "stop-start" funding and accelerating progression through the pipeline.

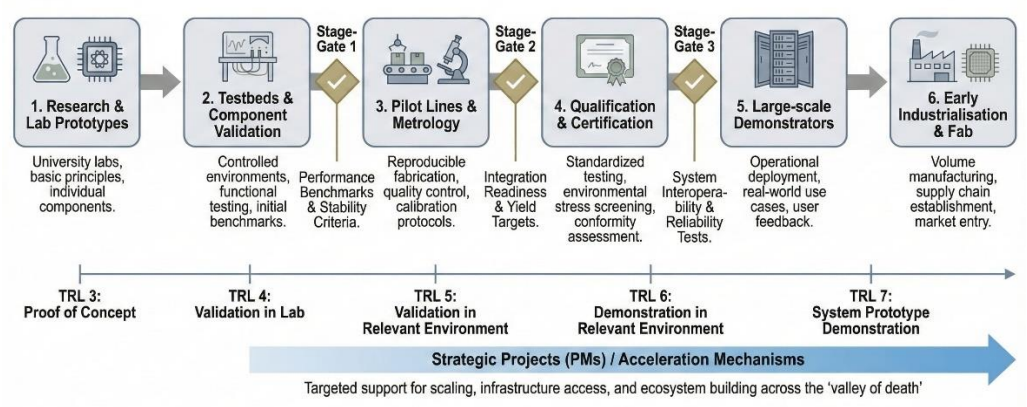

Figure 7.3. *Lab-to-fab pipeline with stage-gates. TRL3–7 pathway showing where testbeds, pilot lines, qualification, Advanced/Pilot Quantum Infrastructure and Strategic Projects sit.*

38. ACCESS, USER SUPPORT AND HYBRID WORKFLOWS (HPC–QUANTUM INTEGRATION)

Quantum systems require specialised access conditions (booking, calibration windows, tooling, security policies, IP/confidentiality handling). For many users—especially SMEs—the main barrier is not theoretical knowledge, but navigation cost: understanding where to access, what prerequisites exist, how to benchmark, and how to integrate results into workflows. "Access + user support" therefore has a technical dimension (interfaces, toolchains, data formats) and an operational one (service catalogues, response times, support expertise).

In practical deployments, quantum computing is often used in hybrid mode, where classical HPC or cloud resources handle large-scale data processing and optimisation loops while the quantum device is used for targeted subroutines. This is why the Act discusses access and adoption in a way that is connected to existing compute infrastructures and user-support networks.

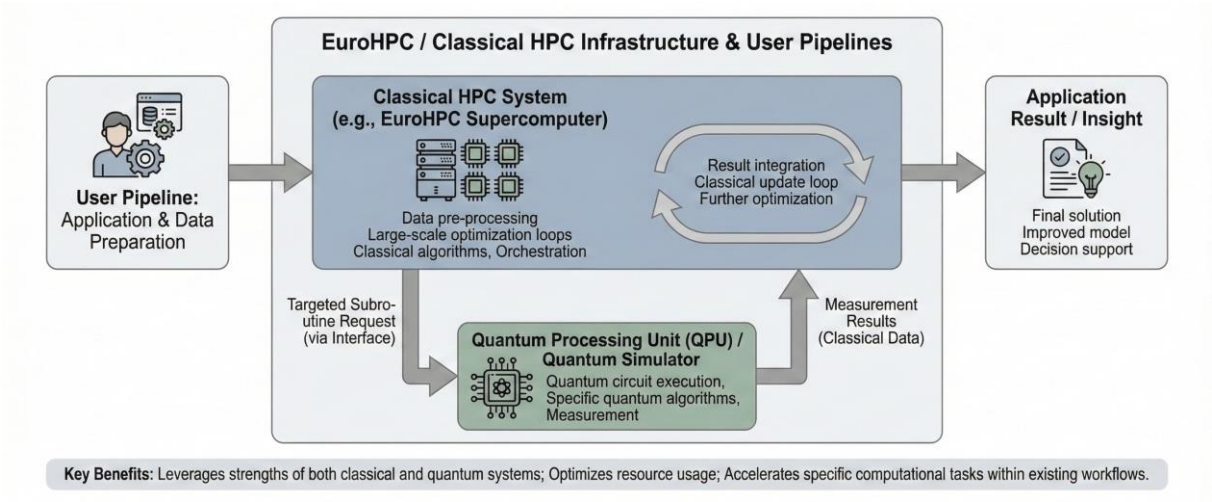

Figure 7.4. *Hybrid classical–quantum workflow. Data preparation → classical optimiser → quantum circuit execution → measurement → classical update loop → application result*

39. TRUST, INTEROPERABILITY AND CONFORMITY (WHY "TRUSTED DEPLOYMENT" MATTERS)

For deployments in defined critical or sensitive contexts, trust requirements become central. "Trusted deployment" refers to the ability to rely on the system's performance, security properties, and interoperability in a way that is consistent across stakeholders (operators, procurers, regulators). Technically, this often requires:

- interoperability profiles (constrained subsets of standards that ensure two implementations actually work together)
- reference implementations / test suites (to reduce ambiguity)
- interoperability testing events (multi-vendor testing of profiles)
- proportionate conformity pathways in defined contexts (evidence that requirements are met)

The goal is not to impose blanket requirements on all quantum activity, but to enable adoption where assurance is necessary and to reduce uncertainty for procurers and operators.

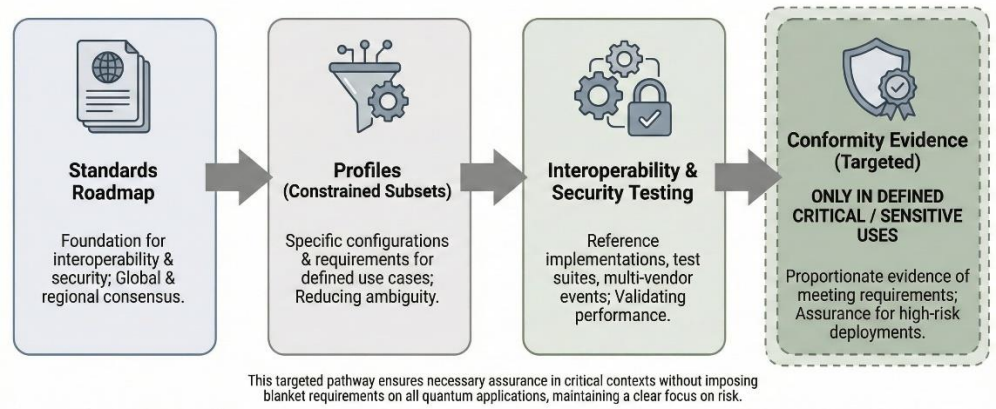

Figure 7.5. *Trusted deployment pathway. Standards roadmap → profiles → reference implementations/test suites → interoperability testing → (where justified) conformity evidence for defined critical/sensitive uses.*

40. DEPENDENCIES, ENABLING TECHNOLOGIES AND RESILIENCE

Quantum systems depend on a set of enabling technologies and components that can be concentrated in limited supply chains: cryogenics, lasers, electronics, specialised materials, optics, detectors, timing and control systems. Resilience requires visibility of chokepoints, diversification options, and the ability to coordinate mitigation when risks become systemic. This motivates the Act's focus on dependency mapping, monitoring/early warning, and targeted Strategic Projects for chokepoints.

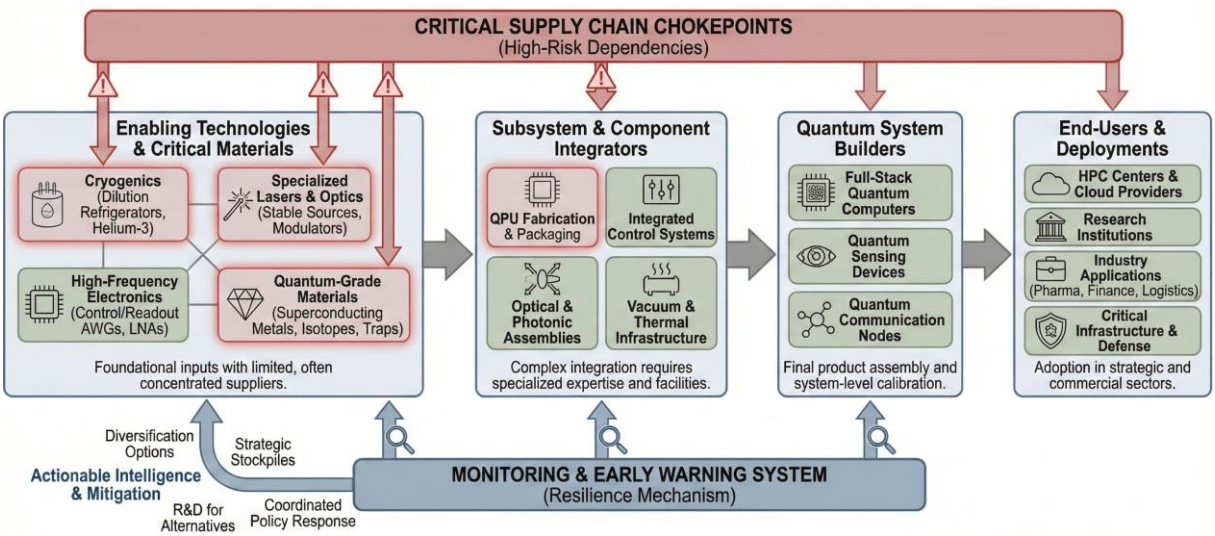

Figure 7.6. *Quantum supply chain "chokepoints map". Enabling components → subsystem integrators → system builders → deployments/users, with highlighted high-risk dependencies*

ANNEX 8: DETAILED IMPLEMENTATION AND IMPACTS

41. PURPOSE, SCOPE AND ANALYTICAL CONVENTIONS

This annex provides the detailed assessment of the implications of the retained policy options for the EU Quantum Act relative to the dynamic baseline, Policy Option 0. It expands Chapters 6 and 7 of the Main Report and links the option-level conclusions to the final PM1–PM16 architecture. It also includes a more detailed description of potential impacts of the PMs.

The principal policy horizon is 2030, in line with the Quantum Europe Strategy. Costs are modelled over 2028–2037 in real 2024 prices. Longer-term industrial, resilience and security effects are assessed qualitatively or through scenarios where robust forecasting is not possible.

The assessment distinguishes societal resource costs, administrative burdens, adjustment costs, public-budget expenditure, transfers, financing volumes and scenario-only effects. Financing volumes and public expenditure are not treated automatically as societal costs or benefits. User-fee receipts and transfers are not added to welfare benefits.

Only effects with a sufficiently explicit causal pathway are monetised. Innovation, scale-up, resilience, skills, territorial and long-term productivity effects are principally assessed through qualitative evidence, ranges and monitoring indicators. The central infrastructure case assumes reuse of existing laboratories and centres, with only marginal service and targeted adaptation resources counted. A full-build scenario is retained only as a stress test.

Measures are assessed with technology-neutral criteria and differentiation by maturity. Binding or assurance requirements are considered only for clearly defined mature applications. Uncertainty is reflected through low, central and high assumptions, deterministic scenarios and switching values. All quantitative results are incremental to the dynamic baseline. Monetary values are expressed in real 2024 prices and present value over 2028–2037 using a 3% real discount rate. Societal resource costs, administrative burdens, public-budget expenditure, transfers and financing volumes are reported separately and must not be added together.

42. OVERVIEW OF IMPACT PATHWAYS AND PRINCIPAL POLICY MEASURES.

Impact pathway and principal policy measures	Main expected positive effects	Main potential negative effects and trade-offs	Differences across the options	Evidence and uncertainty
EU-level coordination of activities and strategic programming: PM1, PM15 and PM16	Better alignment of Union and national priorities, and identification of gaps. Coordination can bring economies of scale (avoiding fragmentation and waste of resources) and faster technological progress through prioritisation, by focusing financial and human resources on agreed S&T objectives, technological and engineering challenges.	Stronger coordination may require more time to establish and may reduce the flexibility of national programmes.	PO1 relies on voluntary alignment. PO2 introduces structured planning and review mechanisms. PO3 maintains the same planning and governance arrangements as PO2.	High confidence for institutional outputs and costs; medium confidence for reduced fragmentation and improved alignment of investments.
R&I excellence, industrialisation and deployment: PM2–PM6	Greater scientific critical mass to address grand S&T challenges; accelerated progress from research and technology development to industrialisation; faster quantum deployment.	Risk of premature technology choices, under-utilisation of facilities, geographic concentration and opportunity costs for other R&I priorities.	PO1 primarily improves cooperation and information exchange on a voluntary basis. PO2 establishes Grand Challenges, Hubs, Centres and Strategic Projects. PO3 maintains the same arrangements as PO2.	Medium confidence; effects depend on technological maturity, the quality of selected facilities, the demand for facilities, utilisation rates and available programme resources.
Scale-up finance and strategic capabilities: PM5, PM10 and PM12	Improved investment readiness and greater continuity of financing; enhanced opportunities for co-investment between EU and MS and public financial actors and private investors, and stronger capacity to retain strategically important firms and capabilities.	Crowding out of private finance, financial exposure to technological failure, selection risks and concentration of support.	PO1 supports investor coordination and referral mechanisms. PO2 establishes a structured investment pipeline through existing or future instruments. PO3 introduces dedicated mandate or risk-bearing capacity (cf. PM10).	Medium confidence in improved financing coordination; lower confidence in additional investment, firm growth and outcomes related to strategic capabilities.

Demand, first buyers and SME market access: PM5, PM6, PM7 and PM12	Stronger links between suppliers and users, reference deployments, customer validation, and the use of innovation procurement to help translate pilots into follow-on demand and wider market uptake.	Procurement price premiums, reduced bidder participation in procurements, the purchase of immature technologies and risks of technology lock-in.	PO1 sets voluntary frameworks for coordination among buyers. PO2 supports coordinated PCP/PPI and reference deployments based on common use cases and functional specifications. PO3 applies mandatory requirements in wider, predefined procurement categories.	Medium-to-low confidence as effects depend on buyer participation, supplier availability, market maturity, procurement scale and the extent to which initial procurement translates into repeat demand.
Skills, social and territorial impacts: PM6 and PM9, supported by PM2-PM6	Increased technical, engineering and user capabilities; practical training and mobility; broader access to support and expertise across Member States.	Skills shortages and wage pressure may increase; benefits may concentrate in established firms, universities and competence centres; smaller or weaker ecosystems may face access barriers.	PO1 improves information provision and sharing. PO2 connects skills and user support to projects, facilities and procurement. PO3 has the same arrangements as PO2.	Overall positive effects are expected, but employment and regional outcomes cannot be reliably assessed until programme scale, project location and market demand are clearer.
Standards, trusted deployment and quantum-safe preparedness: PM8 and PM13, supported by PM7	Greater comparability, interoperability across quantum and quantum-classical hybrid platforms; and buyer confidence; lower testing and due-diligence costs; stronger PQC implementation preparedness.	Premature standards or assurance requirements could create technological lock-in; testing and compliance costs may impose a disproportionate burden on SMEs; risk of overlap with cybersecurity frameworks.	PO1 supports voluntary pre-standardisation activities but adds no PQC-specific measure beyond the baseline. PO2 adds a biennial preparedness assessment, coordinated exercises, PQC requirements in public procurement and structured QSB–NIS Cooperation Group cooperation alongside standards and testing. PO3 further introduces binding implementation of the PQC roadmap, including testing, verification and certification in critical infrastructures.	Medium confidence as regards coordination and preparedness. Benefits stemming from the baseline PQC transition are not attributed to the Act; any additional avoided- effects in terms of security-loss remain highly uncertain.

Dependencies, resilience and international cooperation: PM11 and PM14, supported by PM5, PM7 and PM10	Improved visibility of chokepoints, and critical technology dependencies, earlier warning of emerging vulnerabilities, greater diversification, enhanced qualification of alternative-supplier and trusted international partnerships.	Costs related to supply chain mapping and mitigation; potential exposure of trade secrets; possible constraints on beneficial investment, cooperation and supplier choice.	PO1 relies on publicly available and voluntary information to map the quantum supply chain. PO2 introduces targeted information requests and referrals for mitigation measures. PO3 extends mandatory reporting and mitigation planning to a broader set of defined critical categories.	Medium confidence as regards improved visibility; lower confidence as regards disruption avoidance, substitution lead times and the effectiveness of mitigation measures.
Environmental and resource impacts: PM3–PM5 and PM7	Shared infrastructure may improve utilisation rates and avoid unnecessary duplication of capacity; selected applications may support improvements in energy use, materials, logistics and environmental monitoring.	Additional impacts may arise from electricity demand, cooling, water, cleanroom requirements, specialist-material and equipment-related waste; under-utilised infrastructure may generate environmental costs without corresponding benefits.	PO1 has limited direct effects. PO2 may generate localised impacts through selected facilities and their deployment. PO3 has the same central infrastructure configuration as PO2; any higher impacts would arise only from separate future deployment decisions.	Low-to-medium confidence. Effects depend on technology mix, utilisation rates and energy sources. Application-level benefits should be recognised only where they are demonstrated against relevant conventional alternatives.
Administrative burden and implementation: PM5, PM7, PM8, PM11 and PM13	Improved cybersecurity preparedness, lowering the risk of incidents, data breaches and service disruptions. Transparent project and access procedures make requirements clearer and more predictable, reducing delays and duplications. Digital and reusable information processes further simplify administrative burdens.	Possible effects concern the freedom to conduct business, intellectual property, personal data protection, trade secrets, equal treatment and the right to good administration, as well as additional staffing, application, monitoring and compliance costs.	PO1 has limited direct implications. PO2 would introduce targeted obligations for clearly defined actors. PO3 would affect a broader set of actors and require stronger safeguards, enhanced supervision and greater administrative capacity.	High confidence in the relative ordering of costs but only a medium level of confidence in realised simplification savings and implementation capacity.

Table 8.1. *Impacts per related group of Policy Measures*

43. DETAILED IMPACTS BY INTERVENTION DIMENSION

Dimension	PO1	PO2	PO3	Evidence and uncertainty
Coordination and programming	Better information exchange and voluntary alignment; coverage depends on participation	Common planning and review covering all Member States, with structured national inputs	Binding multiannual planning, broader reporting and stronger central steering	High confidence for institutional coverage; medium confidence for reduced fragmentation and improved investment alignment
R&I and industrialization	Improved visibility and navigation; no formal hubs or Strategic Projects	Selected hubs, user-support Centres, Grand Challenges, Strategic Quantum Infrastructuress and Strategic Project designation	Same physical infrastructure profile as PO2; more centralised portfolio management and stronger priority treatment. Additional capacity is outside the central quantified case.	Medium confidence; depends on facility selection, utilization, program resources and technology maturity
Scale-up finance	Investor coordination, finance readiness and referral	Structured investment pipeline and thematic window within existing instruments	Dedicated risk-bearing financial capacity	Mobilization scenarios suggest EUR 150–350m of private co-investment per EUR 100m of Union risk-bearing finance; illustrative, not a forecast
Demand and first buyers	Buyer groups, market consultation and guidance	Coordinated PCP/PPI, reference deployments and targeted conditions in selected strategic procurements	Broader preference or eligibility conditions across defined categories	Medium-to-low confidence; depends on buyer participation, market maturity, pipeline size and supplier availability
Skills and user capabilities	Better information and voluntary coordination	Training, mobility and user-support actions linked to infrastructures, projects and procurement	Broader national planning and reporting	Positive direction expected, but employment and skills totals cannot be forecast before program scale and demand are known

Standards and quantum-safe deployment	Pre-standardization support; no additional PQC-specific measure beyond the baseline	Structured standards and benchmarking programme; voluntary assurance; structured cooperation between the Commission, Member States and relevant bodies on implementation of the PQC roadmap; biennial preparedness assessment, coordinated exercises and PQC requirements in public procurement	PO2 structured standards and PQC cooperation, supplemented by binding implementation of the existing PQC roadmap through time-bound migration requirements for defined critical public authorities and, where justified, critical operators.	Medium confidence for coordination and assurance pathways. PM13c costs and effects are sensitive to the covered population, reporting frequency, reuse of existing plans and inventories, and supervisory intensity. Avoided-security-loss effects remain scenario-only and do not affect the central ranking.
Dependencies and resilience	Voluntary dashboard and existing cooperation channels	Scoped strategic mapping, targeted requests, early warning and links to mitigation	Broader ecosystem reporting and stronger monitoring coverage	Medium confidence for visibility; lower confidence for the scale and timing of avoided disruption

Table 8.2. *Detailed impacts by intervention dimension.*

44. BASELINE INDICATORS PER SPECIFIC OBJECTIVE

Specific Objective	Baseline	Indicators
SO-A – R&I alignment and delivery	Fragmented programming despite substantial investment: EU and Member States invest significantly in quantum, but priorities, programmes and investments remain insufficiently coordinated.	• Share of MS quantum strategies/programmes aligned with common EU priorities • Number of joint/co-programmed EU-MS R&I initiatives
SO-B – Lab-to-fab and shared infrastructures	Limited industrialisation capacity: six quantum chip pilot lines and a quantum design facility are being established; access to existing infrastructure remains fragmented.	• Number and capacity of EU-accessible pilot lines/design/fab facilities • Cross-border users/projects • Time and cost from prototype to industrial validation • Technologies progressing from lab to pilot/production
SO-C – Scale-up and financing continuity	Strong start-up base but weak scale-up: the EU hosts about one-third of global quantum companies, but has a much smaller share of global quantum patents and private investment.	• Annual EU quantum VC/private investment • EU share of global quantum VC • Number/value of Series B+ investments • EU quantum companies scaling in Europe
SO-D – Demand pull and first buyers	Market uptake lags scientific and entrepreneurial strength: Europe has a strong company base, but limited lead-user engagement, reference deployments and repeat procurement.	• Number/value of public and industrial procurements • Reference deployments progressing to repeat procurement

Specific Objective	Baseline	Indicators
		• Number of industrial/public users • EU quantum technology revenues
SO-E – Skills and user support	Strong scientific base but industrial skills shortages: Europe has a large quantum talent pool, but shortages remain in engineering, software, technical, operational and user-side skills.	• Quantum graduates and industry professionals • Quantum vacancies / skills gaps • People trained through EU/MS programmes • Cross-border mobility of quantum talent
SO-F – Trusted and quantum-safe deployment	Standards and assurance are still developing: common EU approaches to standards, benchmarking and testing are not yet established across the ecosystem; Member States are beginning to implement the coordinated PQC roadmap.	• European/international standards and benchmarks adopted • Technologies/products assessed against common methods • MS implementation of PQC roadmap milestones • Critical systems assessed for PQC readiness
SO-G – Dependencies and economic security	Critical dependencies remain insufficiently mapped: supply-chain assessments are being developed across materials, precision components, control electronics and software.	• Share of critical value-chain segments covered by dependency assessments • Critical dependencies with mitigation measures • Supplier concentration for critical components • EU share of production/capacity for strategic components

45. OVERVIEW OF PRINCIPAL EXPECTED EFFECTS BY INTERVENTION DIMENSION

Specific objective and principal policy measures	Main expected positive effects	Main potential negative effects and trade-offs	Differences across the options
SO-A – Improve EU–Member State R&I alignment and delivery to sustain S&T excellence – PM1, PM15, PM16	Economies of scale through reduced fragmentation and the elimination of avoidable duplication; concentration of financial and human resources around agreed S&T, technological and engineering priorities; improved identification of gaps and better coordination of investments and implementation; potentially faster technological progress.	Enhanced coordination between EU and Member States takes time and resources to establish; possible overlaps with existing governance structures; excessive central steering could reduce national flexibility.	**PO1:** voluntary information exchange and alignment. **PO2:** structured common programming, a Strategy Board and review. **PO3:** the same programming and governance arrangements as PO2.
SO-B – Reduce lab-to-fab bottlenecks and improve access to shared industrialisation infrastructures – PM2–PM6	Greater scientific and technological critical mass; accelerated progress from research and technology development to industrialisation; improved cross-border access to and use of specialised capabilities.	Premature technology choices; under-utilisation of facilities; geographical concentration; opportunity costs if resources are concentrated on unsuccessful pathways.	**PO1:** voluntary research cooperation, mapping and access to information. **PO2:** S&T Excellence Network, Grand Challenges, Hubs, Strategic Quantum Infrastructuress, Strategic Projects and Acceleration Centres. **PO3:** same as PO2.
SO-C – Improve	Improved investment	Risk of crowding out	**PO1:** investment-

scale-up conditions through de-risking and financing continuity – PM5.2, PM10, PM12	readiness and continuity of financing (from grants to private investment and later-stage finance); stronger co-investment opportunities between Union and national financial actors and private investors; enhanced capacity to scale strategic firms and capabilities in Europe.	private finance; public financial exposure to technological failure; selection and concentration risks; effectiveness depending on investor participation.	readiness support and referral mechanisms. **PO2:** structured financing pipeline and coordination through existing or future instruments. **PO3:** adds dedicated mandate or risk-bearing financial capacity.
SO-D– Strengthen demand pull and support pathways to first buyers and wider deployment – PM5.1, PM6, PM7, PM12	Stronger buyer–supplier linkages; more coordinated innovation procurement; operational validation and reference deployments; progression from pilots towards repeat procurement and broader market demand.	Buyer preparation and procurement costs; risk of purchasing immature solutions or creating technological lock-in. Under PO3, sourcing or eligibility conditions could reduce the pool of available suppliers and raise procurement costs where market alternatives are limited.	**PO1:** voluntary buyer groups, market consultations and guidance. **PO2:** coordinated PCP/PPI and reference deployments based on common use cases and functional specifications. Targeted sourcing or eligibility conditions in predefined strategic procurements where objectively justified. **PO3:** PO2 plus application of stronger and/or common conditions to predefined strategic procurement categories.
SO-E – Improve targeted skills and user support for deployment – PM6, PM9, supported by PM3–PM5 and PM7	Greater availability and mobility of engineering, software, technical, operational and user-side capabilities; more practical training linked to projects and infrastructures; improved capacity among users to identify, assess and adopt quantum solutions.	Increased training and coordination costs; existing skills shortages may persist despite intervention; benefits may concentrate in already strong ecosystems unless access and mobility measures are effective.	**PO1:** mapping of skills needs and exchange of information on training opportunities. **PO2:** targeted training, mobility and user support measures linked to infrastructures, projects and procurement. **PO3:** same as PO2.
SO-F – Improve trusted and quantum-safe deployment through standards, benchmarking, testing and implementation support – PM8, PM13, supported by PM7	Greater comparability of performance; improved interoperability between quantum components, systems and interfaces; lower testing and due-diligence costs; greater buyer confidence; better coordinated implementation of the existing PQC roadmap.	Premature standardisation or assurance requirements could create technology lock-in and limit flexibility in a rapidly evolving field; testing and compliance costs could impose additional burdens; risk of duplication with existing cybersecurity frameworks if poorly coordinated.	**PO1:** voluntary pre-standardisation and benchmarking support. **PO2:** structured standards, benchmarking and testing, and cooperation on implementation of the PQC roadmap, a biennial preparedness assessment, coordinated exercises and PQC requirements in public procurement. **PO3:** PO2 plus binding implementation of the existing PQC roadmap through time-bound migration requirements.
SO-G – Improve visibility, early	Improved visibility of critical dependencies and	Information and administrative burdens	**PO1:** based on public and voluntary information.

warning and mitigation of critical dependencies – PM11, PM14, supported by PM5.2, PM7 and PM10	supply-chain chokepoints; earlier warning of emerging risks and vulnerabilities; improved supplier diversification and qualification of alternative sources; strengthened connection between identified risks to finance, procurement and trusted international partnerships.	for companies and public authorities; confidentiality and trade-secret concerns; over-classification of ordinary dependencies as critical; nor carefully targeted measures could restrict beneficial supplier choice, investment or cooperation.	**PO2:** risk-based mapping, proportionate targeted information requests and referral of identified risks to existing mitigation instruments. **PO3:** wider targeted mandatory information requests for predefined critical value-chain categories.

Table 8.3. *Overview of principal expected effects by intervention dimension*[8]

46. DETAILED IMPACTS BY POLICY MEASURE

Measure	Drivers and objectives	Main benefits	Main costs and risks	Safeguards	Option conclusion
PM1 – Common programming framework	PD1; SO-A	Improves common review, priority alignment and visibility of implementation gaps	Commission and Member State staff time; risk of duplicate governance	Separate strategic review from operational decisions; common calendar and templates	PO2 materially improves coverage; PO3 adds certainty but higher burden and centralisation risk
PM2 – Quantum Science and Technology (S&T) Excellence Network	PD1 and PD3; SO-A, SO-B and SO-E	Strengthens scientific cooperation, critical mass, mobility and links to later stages	Coordination and participation costs; risk of concentration	Open excellence criteria, distributed participation and periodic review	Positive under all options; stronger institutional continuity under PO2/PO3
PM3 – Quantum Grand Challenges	PD1, PD2 and PD3; SO-A, SO-B and SO-E	Focuses resources on shared bottlenecks and creates measurable progression	Programme administration and risk of premature technology selection	Technology neutrality, staged competition, independent review and stop rules	PO1 is limited to voluntary challenge mapping; meaningful additionality arises under PO2; PO3 uses the same design as PO2. no material extra design benefit under PO3
PM4 – Technology and Innovation Hubs	PD2; SO-B	Reduces search and access barriers and improves use of shared facilities	Marginal service and adaptation resources; risk of low utilisation or duplication	Existing capacity first, demand assessment, transparent access and utilisation review	PO2/PO3 central case uses the same existing-infrastructure profile

[8] The PM references identify the principal causal pathway and are not mutually exclusive. Territorial, environmental, fundamental-rights, administrative and implementation impacts cut across several measures and are assessed in Sections 6.4–6.5 of the Impact Assessment.

PM5 – Strategic Quantum Infrastructures and Strategic Quantum Projects	PD1–PD5 and PD7; SO-A–SO-D and SO-G	Improves coordination, visibility, milestones and access to relevant support pathways	Application, review and monitoring costs; risk of automatic advantage or concentration	Transparent criteria, reasoned decisions, review and no automatic entitlement	PO2 balances visibility and safeguards; PO3 stronger rights/obligations increase lock-in and rights risks
PM6 – Competence and Acceleration Centres	PD2, PD3 and PD5; SO-B, SO-D and SO-E	Helps firms and users identify use cases, facilities, finance, skills and suppliers	Operating costs and possible proliferation of centres	Reuse suitable existing structures; common minimum services and performance indicators	PO2/PO3 improve coverage; effects depend on service quality and demand
PM7 – Innovation Procurement	PD5 and PD6; SO-D and SO-F	Creates early demand, reference customers, feedback and potential follow-on revenue	Buyer costs, possible price premiums, reduced competition and lock-in	Functional specifications, staged PCP/PPI, multiple suppliers and market analysis	PO2 targeted use is proportionate; PO3 broader restrictions materially increase risk
PM8 – Standards, benchmarking and assurance	PD6; SO-F	Improves comparability, interoperability, testing and trusted deployment	Standards participation and testing costs; risk of premature lock-in	Maturity triggers, technology neutrality, shared testing and periodic review	PO2 voluntary approach is proportionate; PO3 uses the same measure variant as PO2 (PM8b)
PM9 – Skills and mobility	PD3; SO-E	Improves deployment-linked engineering, software, procurement, operational and user capabilities	Programme and participation costs; possible duplication of education initiatives	Use existing programmes, employer and user evidence, and targeted profiles	PO3 planning obligations do not by themselves increase talent supply
PM10 – Quantum Investment Service Desk	PD4; SO-C	Improves investment readiness, referrals, syndication and continuity between support stages	Public-budget exposure, crowding out and concentration risk	Independent investment decisions, additionality tests and private risk-sharing	PO2 uses the Quantum Investment Service Desk through existing or future instruments. PO3's dedicated mandate or capacity within existing or future financial instruments' envelope increases budgetary, governance and additionality risks but does not require a new institution.

PM11 – Strategic intelligence and dependency monitoring	PD7 and PD1; SO-G and SO-A	Improves visibility of dependencies, bottlenecks and mitigation needs	Information burden and confidentiality or security risks	Risk-based scope, data minimisation, secure handling, thresholds and once-only reuse	PO2 scoped mapping is proportionate; PO3 broader reporting increases coverage and burden
PM12 – Quantum Business Platform	PD4 and PD5; SO-C and SO-D	Supports matchmaking among firms, users, investors and partners	Platform operation costs, data-quality risk and possible market distortion	Voluntary participation, neutral governance and separation from regulatory monitoring	Similar substantive benefits under PO2/PO3; dependent on uptake
PM13 – Quantum-safe preparedness	PD6; SO-F	Improves implementation support, migration planning, cryptographic-asset visibility, progress monitoring and crypto-agility or PQC-readiness.	Administrative, adjustment and supervisory costs; possible duplication with cybersecurity obligations; disproportionate fixed costs for smaller covered actors.	Risk-based scope and thresholds; alignment with the existing roadmap and sectoral frameworks; reuse of existing plans and inventories; proportionate frequency; implementation through existing competent authorities.	PO1 adds no measure beyond the baseline, PO2 adds a biennial preparedness assessment, coordinated exercises, PQC requirements in public procurement and implementation-support functions of different intensity. PO3 provides greater preparedness coverage but is a major cost, burden, feasibility and coherence driver.
PM14 – Strategic international cooperation	PD4, PD6 and PD7; SO-C, SO-F and SO-G	Supports research, standards, supply diversification, reciprocity and market access	Coordination and research-security costs; possible restriction of beneficial cooperation	Criteria-based partnerships, proportional safeguards and consistency with international commitments	PO2/PO3 provide more strategic coordination than PO1
PM15 – Quantum Strategy Board	PD1; SO-A	Links Union priorities with structured national inputs and implementation review	Preparation and reporting burden; possible reduction of national flexibility	National budgets remain national; proportionate chapters and once-only data reuse	PO2 provides durable coordination; PO3 has stronger coverage but higher burden

PM16 – European Quantum Alliance	PD1–PD6; SO-A–SO-F	Improves stakeholder intelligence, user and industry input and policy feedback	Participation and secretariat costs; risk of duplicating formal advisory bodies or capture by organised interests	Light open interface, balanced representation and routing to competent bodies	PO1/PO2 benefits depend on participation; PO3 formal compliance regime is less proportionate

Table 8.4. *Detailed impacts per PM*

47. AFFECTED STAKEHOLDERS AND PRACTICAL IMPLICATIONS

Affected stakeholder	Actions required or expected	Main costs and risks	Main benefits
Commission and Union services	Operate the Board and review cycle; maintain common methods and intelligence tools; coordinate Strategic Project, infrastructure, finance, procurement, standards and monitoring functions.	Staff, analytical, governance, data-management and coordination resources; risk of overlap if institutional interfaces are unclear.	More coherent Union action; improved evidence; earlier identification of delivery gaps and dependencies; stronger policy learning.
Member State authorities and public buyers	Prepare national quantum chapters; participate in governance, procurement, skills, PQC and resilience cooperation; provide information for the biennial PQC preparedness assessment, take part in coordinated exercises and apply PQC requirements in public procurement; validate proportionate national information.	Administrative and technical resources; possible capacity constraints in smaller administrations.	Better visibility of Union and national priorities; opportunities for joint action; lower duplication; access to common evidence and methodologies.
Implementing bodies, Joint Undertakings and agencies	Administer relevant calls, access arrangements, projects and monitoring; assess milestones and coordinate with the Board and programme authorities.	Additional programme-management and technical-assessment tasks.	More coherent pathway from R&I to infrastructure, finance, procurement and deployment; improved programme additionality.
Quantum start-ups, SMEs and scale-ups	Voluntarily apply for facilities, finance, projects, procurement or user support; provide proportionate information where supported or specifically covered by a targeted request.	Application, monitoring, testing and qualification costs; risk of disproportionate fixed costs or incumbent advantage.	Improved access to facilities, finance, customers and reference deployments; lower search costs; stronger investor and buyer confidence.
Larger quantum firms and system integrators	Participate in projects, procurement, standards, deployment, business matchmaking and supply-chain cooperation.	Project, reporting and assurance costs; possible restrictions in defined strategic procurements under higher-intensity designs.	Larger and more predictable European market; stronger supplier and infrastructure base; cross-border deployment opportunities.
Infrastructure operators, RTOs and universities	Publish service catalogues; apply common access principles where supported; report utilisation and outcomes proportionately; provide technical user support.	Adjustment of access processes; service, monitoring and user-support resources.	Higher utilisation; broader industrial and cross-border user base; stronger links between research, engineering and deployment.

Component and enabling-technology suppliers	Respond to targeted requests where justified; support alternative-supplier qualification, diversification or contingency planning where relevant.	Information and confidentiality-management costs; possible disproportionate burden on small critical suppliers.	Improved demand visibility; support for qualification and capacity development; reduced disruption exposure.
Public procurers and user organisations		Preparation, technical-assessment and learning costs; risk of purchasing immature solutions.	Better specifications and market intelligence; shared procurement preparation; access to operational evidence and innovative solutions.
Financial institutions and private investors	Participate voluntarily in investment-readiness, financing and cross-border syndication activities **when relevant transactions or projects arise**. Where participating in implementation monitoring, provide aggregated pipeline and mobilisation information through the applicable reporting arrangements, **normally annually**.	Due-diligence and coordination resources.	Improved project pipeline; lower information asymmetry; opportunities for larger cross-border investments.
Workers, students and researchers	Participate voluntarily in training, mobility, research, engineering and deployment activities **for the duration of the relevant programme, project or training action**. No recurring regulatory reporting obligation is foreseen.	Adjustment of training provision; possible concentration of demand in established clusters.	Greater mobility, specialised training and industrial career opportunities.
Citizens and society	No direct action required.	No direct administrative cost; opportunity cost of public expenditure; possible environmental footprint of additional activity.	Potential long-term benefits from applications, employment and knowledge spillovers; improved continuity and security of digital services.

Table 8.5. *Practical implications by stakeholder group*

48. EXPECTED BENEFITS AND COSTS

48.0. EXPECTED BENEFITS

The preferred option is expected to generate direct process and transaction-cost savings and wider benefits for industrial capability, investment, demand, skills, trusted deployment and resilience. Most wider benefits cannot be monetised robustly because they depend on technological progress, future programme resources, facility use, investor response and buyer participation.

Benefit channel	Main beneficiaries	Expected benefit	Quantified indicator or scenario
Strategic coordination	Commission, Member States and implementing bodies	More complete planning and improved identification of gaps, complementarities and opportunities for joint action.	Structured review and national quantum chapters covering all 27 Member States; monetised coordination savings included within the EUR 13.590 million total modelled savings.

Infrastructure access	SMEs, firms, researchers and users	Lower search and negotiation costs and earlier access to engineering, testing, validation and qualification.	Illustrative scenario: 40–240 project-months per year brought forward if 40–120 projects obtain access one to two months earlier.
Scale-up finance	Start-ups, scale-ups and investors	Greater financing continuity and stronger cross-border syndication.	Illustrative mobilisation range of EUR 150–350 million of private co-investment per EUR 100 million of Union risk-bearing finance. Financing volumes are not treated as welfare benefits.
Demand and first buyers	Suppliers, public buyers and users	Early revenues, reference customers, operational validation and stronger investor confidence.	Illustrative scenario per EUR 100 million of innovation procurement: EUR 25–50 million of persistent supplier revenue and EUR 10–20 million of additional private investment. These are not added to the CBA.
Standards and assurance	Buyers, suppliers and infrastructure operators	More comparable performance claims, lower repeated due diligence and improved interoperability and substitutability.	Tracked through common benchmarks, specifications, test methods and reuse of recognised results; no central monetary value assigned.
Quantum-safe preparedness	Member States, public authorities and critical-system operators	Improved access to technical advice, implementation experience and good practices.	Preparedness assessments, exercises, procurement requirements, advisory outputs and monitoring coordination. Under PO2, the quantified outputs concern the biennial preparedness assessment, coordinated exercises, PQC requirements in public procurement, technical advice, implementation support and monitoring coordination. The PO3-specific binding preparedness duties are costed in Annex 4 and assessed under PM13 in **Table 8.4** and are not attributed to the preferred option.
Supply-chain resilience	Projects, suppliers, authorities and users	Earlier identification of dependencies and support for diversification and alternative-supplier qualification.	Illustrative sensitivity: 19–57 days saved per affected project if 10–30% of delays comparable to documented cases are avoided.
Skills and user capability	Workers, students, firms and public users	Training and mobility better linked to infrastructures, projects, procurement and deployment.	Participation, completion, vacancy-fill, mobility and user-capability indicators; no robust employment total is forecast.
Administrative simplification	Authorities, applicants and beneficiaries	Common taxonomies, templates, digital processes and once-only information reuse.	EUR 13.590 million of modelled savings under PO2: EUR 6.860 million for Member State authorities, EUR 6.450 million for businesses and EUR 0.27 million for implementing bodies.

Table 8.6. *Overview of principal benefits of PO2*

The quantified outcome scenarios use different units and assumptions and are not forecasts. They must not be aggregated into a single benefit figure. Detailed assumptions, causal pathways and sensitivity treatment are presented in Annex 4.

48.1. OVERVIEW OF COSTS OF THE RETAINED OPTIONS

The Standard Cost Model covers the incremental administrative, adjustment, coordination, monitoring and implementation resources generated by the framework. It excludes the substantive value of grants, procurement contracts, financial instruments and capital commitments, which are transfers or financing volumes rather than automatically societal costs.

Central NPV, EUR million, 2028–2037	PO1	PO2	PO3
Core policy machinery	41.44	84.5184.51	142.1515
Incremental Hub/Centre resources	0.00	21.41	21.41
Total societal cost	**41.44**	**105.92**	**163.56**
Modelled monetised savings	5.39	13.59	14.04
Net modelled cost	**36.05**	**92.3492.34**	**149.5252**
Partial benefit-cost ratio	0.13	0.13	0.09

Table 8.7. *Modelled societal costs and modelled savings by option*

The partial benefit-cost ratio is not a complete welfare benefit-cost ratio. It compares total societal cost only with the limited set of time and resource savings that could be monetised with a sufficiently explicit causal mechanism. It excludes most expected benefits relating to industrial capacity, innovation, infrastructure services, private investment, employment, interoperability, resilience and security.

PO2 costs approximately EUR 64.49 million more than PO1, while PO3 costs approximately EUR 57.63 million more than PO2. PO3 is therefore around 54% more costly than PO2 in the central case.

48.2. DISTRIBUTION OF COSTS

Approximately 6565.05.% of PO2 societal costs fall on Commission or Union services and Member State authorities. Including implementing bodies, existing Hub/Centre operators and Commission-financed external experts, approximately 91.77% falls on the public and implementation side. Business-facing costs are concentrated on applicants, beneficiaries, designated Strategic Projects, and actors subject to specifically defined information obligations; they do not apply to the general business population.

48.3. PUBLIC-BUDGET IMPLICATIONS AND FINANCING VOLUMES

Budgetary results are reported separately from societal resource cost. The Layer 2 is the administrative and implementation expenditure of the Commission Commissionand the Member States, costed at resource rates (PO2: EUR 90.28 million NPV, of which EUR 21.41 million for the hub and Centre module; Annex 4, Table 4.25); because it includes Member State costs, it is not a Union-budget figure. Programme envelopes and transfers are memorandum items and must not be added to societal cost figures). Layer 2 is reported only as total budget outflow with the transfer caveat.

Possible program expenditure under PO2 are detailed in ***Table 4.35*** on Annex 4. The amount depends on future Union and national budgetary decisions, including the next Multiannual Financial Framework. The Regulation would not create an automatic funding entitlement for a project, facility or company.

Annex 4 presents a bottom-up planning range for PO2 of EUR 5.19–6.12 billion in indicative Union programme resources, corresponding to approximately EUR 12.90–18.08 billion in total direct programme resources. Separately, broader sector financing needs are estimated at around EUR 50–60 billion, mainly equity; up to EUR 2–4 billion for start-ups, up to EUR 20–25 billion for scale-ups and EUR 25–30 billion for large strategic projects

and foundries. These are ceilings on a financing need, not committed or mobilised finance. These are reported separately from the programme-resource, societal-cost and administrative-cost estimates.

48.4. ONE-IN, ONE-OUT AND SIMPLIFICATION

For the administrative-burden component of the One-In, One-Out (OIOO) approach, administrative burden comprises the incremental cost of administrative activities undertaken solely because of legal obligations, net of business-as-usual costs. Documentation for investment support, time that firms choose to spend in the new structures without a legal requirement, programme expenditure and public-administration resources are excluded from that component, while adjustment costs are identified separately as the second leg of OIOO. As the initiative does not remove existing obligations that qualify as administrative offsets, its net administrative-burden position equals the new administrative burden, which arises only from conditions attached to Union funding, designation and supported procurement, from the requirements for taking part in regulatory sandboxes and the business platform, and from targeted information requests.[9]

OIOO indicator	PO1	PO2	PO3
One-off business administrative burden, nominal	EUR 0	EUR 0.296m	EUR 2.960m
Recurrent business administrative burden, steady-state peak per year	EUR 0	EUR 0.719m	EUR 1.994m
Business administrative burden, NPV	EUR 0	EUR 5.46m	EUR 16.28m
Equivalent annual business administrative burden	EUR 0/year	EUR 0.621m/year	EUR 1.853m/year
Existing obligations removed as administrative offsets	EUR 0	EUR 0	EUR 0
Net OIOO administrative-burden position	EUR 0	EUR 5.46m NPV	EUR 16.28m NPV
Business adjustment costs reported separately	EUR 0	EUR 0	EUR 7.20m NPV
Citizens: new or removed administrative burden	EUR 0	EUR 0	EUR 0

Table 8.8. *Application of the One-In, One-Out approach*

49. OVERVIEW OF IMPLICATIONS AND IMPACTS

This section overviews the main implications of the preferred option, as well as the expected impacts regarding economic, environment, territorial, social and fundamental rights aspects.

49.0. BROADER IMPACTS OF QUANTUM TECHNOLOGIES

Before comparing the policy options, it is necessary to distinguish between the broader potential of quantum technologies and the incremental effects of the initiative.

Quantum computing and simulation can support advances in materials, pharmaceuticals, finance, energy, manufacturing, logistics and other optimisation-intensive activities by offering practical advantages over classical alternatives. Quantum sensing and metrology can improve health diagnostics, navigation, timing, geophysical exploration (e.g. gravity and magnetic field detection, deep earth exploration) and environmental and infrastructure monitoring (e.g. detecting subsidence or changes in underground structures, drought monitoring and water management)[5]. Quantum communications may enhance security in certain use cases. PQC, designed to resist both quantum and classical attacks, will allow the continued secure operation of digital services, critical infrastructures and public administration[35].

These developments could improve productivity, innovation, resilience and preparedness,

[9] European Commission, *Better Regulation Toolbox*, December 2025, Tools #56, #58 and #59, especially pp. 507-512 and 526-543; Jacopo Torriti, *'Standard Cost Model: Three Different Paths and their Common Problems'*, Journal of Contemporary European Research 8(1) (2012), pp. 90-108.

public-services, health, security and the environment[10]. Quantum computing and AI may also reinforce each other: machine learning already supports quantum-system control, error mitigation, circuit design and simulation, while future hybrid quantum-classical supercomputers may support selected AI applications[11]. However, practical quantum advantage for AI applications remains unproven and is therefore not included in the quantified impacts.

However, impacts remain application-specific and uncertain, depending on technological performance, cost, scalability, user adoption and demonstrated advantages over classical alternatives. Quantum technologies may also pose risks, such as threats to existing cryptography, surveillance and dual-use applications, the concentration of strategic capabilities that may destabilise the economy and society, considerable energy, material and waste footprint of specialised infrastructures and shortages in the skilled workforce needed for the functioning of such technologies. The main security risk is the compromise of public-key cryptography, which requires asset inventories, risk-based planning, crypto-agility and coordinated upgrades. PQC is the primary response, with QKD complementing it in limited high security cases[12].

The policy options would not produce these broader effects directly, but could influence their probability, timing, scale and the EU's share of benefits by improving research to deployment continuity, access to engineering and testing capabilities, financing, demand, skills, standards and supply-chain resilience. PO1 would primarily support progress, through voluntary participation. PO2 would create a targeted pathway from scientific excellence to industrialisation and deployment. PO3 could strengthen strategic effects via intensive planning, finance, procurement and dependency monitoring, but would offer little additional benefit over PO2 and may introduce higher administrative burden, market and technological-lock-in risks. Thus, the broader potential of quantum technologies alone cannot justify the most intensive policy option.

49.1. ECONOMIC IMPACTS

Competitiveness and innovation. PO1 provides low-cost coordination but leaves important delivery gaps. PO2 improves continuity from research to testing, industrialisation and deployment through Grand Challenges, shared infrastructure, Strategic Projects, finance and procurement pathways. PO3 offers the strongest formal coverage but creates higher cost, market-access and technology-lock-in risks. PO2 provides the most favourable overall competitiveness balance.

SMEs and start-ups. PO2 should improve access to facilities, finance, users, first buyers and common testing. Its business/private-actor costs are EUR 8.83 million NPV, including EUR 5.50 million of administrative costs (EUR 5.46 million within One-In, One-Out); the balance (EUR 3.33 million) is time that firms choose to spend in the new structures without a legal requirement. Modelled business-side savings are EUR 6.4545 million NPV. No business adjustment costs are modelled under PO2.

Finance and investment. The Quantum Investment Service Desk may improve investment readiness, access to financing and coordination among public and private financing actors. Effects depend on additionality and private participation. PO3's dedicated financing mandate or capacity would entail higher budgetary and governance requirements and potential risks of crowding out existing instruments.

[10] GESDA and OQI, Intelligence Report on Quantum Diplomacy in Action 2025–2026, 2025, p.5.
[11] Alexeev, Y., Farag, M.H., Patti, T.L. et al. Artificial intelligence for quantum computing. Nat Commun 16, 10829 (2025).
[12] GESDA and OQI, Intelligence Report, pp. 28-31.

Demand and market formation. Buyer coordination, PCP/PPI and reference deployments may accelerate customer validation and follow-on demand. The effect is uncertain because technology maturity, procurement pipelines and supplier availability differ by domain. Broader preferences under PO3 may increase prices or exclude suitable products.

Internal market and competition. PO2 principally uses common information, access and support pathways and creates only targeted conditions. PO3 creates greater risks of market fragmentation, reduced competition and barriers to cross-border or international participation. Strategic Project designation must not create an automatic market advantage.

Resilience and economic security. PM11 and PM14 improve visibility, early warning, supplier qualification and diversification. Avoided disruption effects remain difficult to monetise. Measures must preserve beneficial international trade and investment and avoid treating the entire sector as restricted.

Lastly, the initiative is particularly relevant for SMEs and start-ups, which constitute the large majority of the European core quantum-company population mapped for this impact assessment. Enabling-component SMEs and SMEs seeking to adopt quantum solutions form additional affected groups. This SME focus is especially important because capital, advanced infrastructure and specialised talent are increasingly concentrated among a limited number of highly capitalised firms. The detailed SME Test is presented in Annex 6.[13] [14]

49.2. DISTRIBUTIONAL, TERRITORIAL AND SOCIAL IMPLICATIONS

These impacts would mainly relate to employment and skills, access to expertise and infrastructure, participation in the quantum sector and the wider uptake of quantum technologies. They are expected to emerge progressively and unevenly across technologies and regions.

Quantum industrialisation could increase demand for highly qualified scientific, engineering, technical, software, cybersecurity, procurement and interdisciplinary professional profiles. This may, however, intensify existing skills shortages and recruitment bottlenecks in these areas, particularly where specialised expertise remains scarce. Quantum applications, often combined with AI, will support public services in areas such as health diagnostics, designing better medicines or discovering new drugs, navigation and timing, infrastructure and environmental monitoring and secure communications. However, these benefits remain uncertain, as they depend on depend on affordability, successful deployment and demonstrated performance advantages over classical alternatives. These potential benefits should therefore not be attributed solely to the initiative.

Impact	PO1	PO2	PO3
Skills and employment	Limited enabling effect	Training and user support linked to delivery measures	Potentially broader effects, dependent on greater expenditure
Participation and territorial access	Better information and voluntary outreach	Distributed user support linked to specialised cross-border facilities	Wider capacity, but greater risk of concentration or duplication
Application-level benefits	Possible but highly uncertain	Greater scope for validated applications	Potentially wider deployment; benefits not assumed ex ante

[13] McKinsey & Company (2026), *Quantum Technology Monitor 2026: A commercial tipping point*, 2026. especially pp. 27, 34-40 and 63. The statement on the SME share is based on the company mapping underpinning this impact assessment; McKinsey is cited for the external evidence on investment concentration, infrastructure and talent.

[14] Oliver Mallett, Robert Wapshott and Tim Vorley, *'How Do Regulations Affect SMEs? A Review of the Qualitative Evidence and a Research Agenda'*, International Journal of Management Reviews 21(3) (2019), pp. 294-316. The review identifies threshold effects, perceived burden, and regulatory stability and consistency as key dimensions of SME impacts.

Employment effects cannot be estimated robustly before programme budgets, project selection and technology demand are known. Monitoring should therefore focus on participants, placements, vacancy indicators, firm growth and user capability rather than an unsupported aggregate job forecast.

Europe has around 40 specialised quantum-technology or quantum-engineering master's programmes, but expected graduate output remains below anticipated industrial needs. These findings support targeted training, mobility and user-capability measures, but do not justify forecasting net employment creation.

Lastly, territorial effects would depend on the location of specialised facilities and the practical accessibility of their services. The PPMI/d-fine study mapping identified 91 testbeds and 27 pilot lines, but only 18 testbeds and 8 pilot lines were identified as open to start-ups[68]. While coverage is incomplete, this illustrates the limited visibility and uneven accessibility of existing facilities rather than an overall shortage of capacity.

In consequence, PO1 would improve information on existing capabilities but would not materially change their geographical accessibility. PO2 would combine first-level user support, aiming at one access point per Member State with specialised capability-based Hubs serving users across borders. PO3 would retain the same territorial architecture.

49.3. ENVIRONMENTAL IMPLICATIONS

Environmental effects[15] may arise directly from the production, operation and end-of-life treatment of quantum hardware and related facilities, and indirectly, through downstream applications that may support or undermine sustainability objectives. Overall, quantum technologies could deliver environmental benefits through scientific discovery, modelling, sensing and optimisation relevant to the green transition, including advances in materials and energy technologies, optimisation of logistics and energy systems, climate modelling and more precise environmental and infrastructure sensing[16].

Quantum computing could require substantially less electrical power than today's most powerful classical supercomputers. Leading exascale supercomputers consume tens of megawatts, while many quantum-computing platforms, especially the most energy-efficient architectures, are expected to operate with system-level power requirements two to three orders of magnitude lower. This potentially substantial reduction in power demand could lower operating costs and ease pressure on electricity infrastructure as quantum computing scales.

Energy efficiency may also become a key competitiveness and scalability factor for quantum systems. According to input from QuIC[17] and the Quantum Energy Initiative[18], energy use should be evaluated at the full-system level encompassing the entire hardware and software

[15] The environmental assessment examines the additional footprint linked to the capacity supported by the forthcoming legislative intervention, including cases where quantum capabilities are integrated into HPC/AI infrastructure. It does not attribute the overall energy footprint of AI/datacentres to the forthcoming legislation.
[16] Root, D., Quantum Technologies in the Context of Climate Change: Emphasizing Sustainability in a Responsible Innovation Approach to Quantum Innovation, NanoEthics, Vol. 19 (2025); Auffèves, A., Quantum Technologies Need a Quantum Energy Initiative, PRX Quantum, Vol. 3 (2022); kiutra and CIRCULAR REPUBLIC, Circularity in the Quantum Industry: Securing Our Quantum Future Through Circular Economy Strategies, white paper (2026).
[17] The European Quantum Industry Consortium (QuIC) is an industry-led association that unites European businesses, research centres, and startups to foster a competitive commercial ecosystem for quantum technologies.
[18] The Quantum Energy Initiative is a global consortium of scientists and industry experts focused on understanding, optimizing, and reducing the environmental footprint and energy consumption of quantum computing and technologies.

stack and supporting classical computing. The initiative recommends developing comparable energy and power metrics for R&I, infrastructure and procurement. Such benchmarks could help identify architectures and applications that deliver practical performance with lower operating costs and reduced energy infrastructure demands. However, any claimed quantum energy advantage should be demonstrated for the specific application against the best classical alternative and should not be assumed in advance[19].

Shared facilities and cross-border access could also improve resource utilisation and efficiency by avoiding duplication. By contrast, supporting under-used facilities would impose environmental costs without matching industrial or societal benefits. Expected demand and utilisation should therefore inform project selection and periodic review.

Potential negative impacts include increased demand for energy-intensive infrastructure, pressure on scarce materials and additional electronic and industrial waste. Relevant facilities and projects should monitor, where proportionate, energy use and greenhouse-gas emissions, cooling and water needs, specialist-gas and material use, utilisation, and equipment end-of-life.

PO2 may increase operational energy, cooling-related resource use, consumables and equipment-related impacts where it induces additional services, equipment or infrastructure adaptation. Available life-cycle evidence shows that results depend on hardware architecture, operating time, error-correction overhead and the electronic components required for a functionally equivalent workload. Infrastructure operators and supported projects should therefore monitor operational energy, cooling, consumables, equipment lifetime, utilisation and relevant embodied impacts per validated workload, where proportionate[20;21].

Reuse, remote access and federation of existing facilities may avoid unnecessary duplication and improve utilisation, while cloud access can permit experimentation without each user acquiring dedicated on-site hardware. Conversely, under-used or prematurely constructed capacity would increase environmental and budgetary costs without corresponding benefits. The central model therefore assumes reuse of existing infrastructure and treats a full-build configuration only as a stress test[20;22].

Potential environmental benefits from quantum applications, including in net-zero power-system optimisation, are not counted ex ante unless demonstrated against the best available classical alternative using a functionally equivalent workload. The comparison should include hybrid processing, sampling, error-correction and relevant infrastructure overheads, since peer-reviewed evidence indicates that any environmental or energy-efficiency advantage is workload-specific and conditional on hardware and algorithmic performance[20;23].

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[19] QuIC and Quantum Energy Initiative, The EU quantum energetic strategic advantage, 17 October 2025; Fellous-Asiani et al., The energetic challenges of fault-tolerant quantum computing, 29 June 2026.

[20] Sylvain Cordier, Karl Thibault, Marie-Luc Arpin and Ben Amor, *'Scaling up to problem sizes: an environmental life cycle assessment of quantum computing'*, Quantum Science and Technology 10(2) 025058 (2025). The central-model infrastructure assumptions stated in the paragraph remain internal model assumptions.

[21] European Commission, Better Regulation Toolbox, December 2025, Tool #66.

[22] McKinsey & Company (2026), *Quantum Technology Monitor 2026: A commercial tipping point*, 2026, p. 79.;

[23] Daniel Jaschke and Simone Montangero, *'Is quantum computing green? An estimate for an energy-efficiency quantum advantage'*, Quantum Science and Technology 8(2) (2023), 025001; Thomas Morstyn and Xiangyue Wang, *'Opportunities for quantum computing within net-zero power system optimization'*, Joule 8(6) (2024), pp. 1619-1640.

49.4. FUNDAMENTAL RIGHTS AND SUSTAINABLE DEVELOPMENT GOALS IMPLICATIONS

Measure	Right or interest affected	Required safeguards
Information requests and reporting	Data protection, trade secrets and freedom to conduct a business	Defined purpose and population, necessity, minimisation, confidentiality, once-only reuse and review rights
Project designation, access and support	Equal treatment, property interests and freedom to conduct a business	Transparent criteria, reasoned decisions, right to be heard, review and withdrawal procedures
Procurement and eligibility conditions	Equal treatment, market access and business freedom	Prior market analysis, proportionality, availability tests and transparent exceptions
Standards and assurance	Technological neutrality and compliance costs	Maturity triggers, phased application, defined scope and periodic review
Security-sensitive participation conditions	Academic freedom, openness of research and international cooperation	Risk-based assessment and distinction between open research and sensitive deployment

Table 8.10. *Fundamental-rights and procedural safeguards.*

Sustainable Development Goal	Expected contribution	Qualification
SDG 4 – Quality education	Skills, training, mobility and user-capability measures.	Positive direction, dependent on program resources and participation.
SDG 8 – Decent work and economic growth	Support for firm growth, investment, deployment and specialized employment.	Positive direction; no aggregate employment forecast.
SDG 9 – Industry, innovation and infrastructure	Improved research-to-deployment pathways, shared infrastructure, finance and procurement.	Principal expected positive contribution.
SDG 12 – Responsible consumption and production	Shared facilities and supplier qualification may improve utilization and equipment longevity.	Mixed; additional activity may also use energy, water, materials and specialist gases.
SDG 13 – Climate action	Future quantum applications may support energy, materials and climate analysis.	Potential benefit not counted without application-level evidence.
SDG 16 – Peace, justice and strong institutions	More resilient and quantum-safe public and critical systems; transparent governance and safeguards.	Positive, subject to effective implementation and protection of confidential information.
SDG 17 – Partnerships for the goals	EU–Member State cooperation, cross-border projects and trusted international partnerships.	Positive.

Table 8.11. *Contribution to relevant Sustainable Development Goals*

50. TRADE OFF AND SYNERGIES

Issue	Synergies	Trade-offs
Coordination and investment	Better alignment of R&I, infrastructure, finance and procurement can strengthen overall effectiveness and support more coherent investment decisions.	Stronger steering may reduce flexibility and may limit the ability of actors to respond to emerging needs or technological developments

Infrastructure and access	Shared facilities can widen access, improve utilisation rates and support more efficient use of resources.	Concentration may reinforce existing clusters; geographical dispersal may duplicate capacity and reduce efficiency
Finance and demand	Lead customers and procurement revenues can facilitate investment by improving market visibility and reducing uncertainty.	Public support may crowd out private finance or favour technologies that remain sufficiently immature
Procurement and resilience	Procurement can create early demand, accelerate market formation and supports security of supply.	It may increase prices and reduce supplier choice particularly where competition is limited.
Standards and assurance	Common standards and assurance mechanisms can improve comparability, interoperability and trust.	Requirements introduced too early may create technological lock-in and constrain innovation.
Skills and deployment	Projects and facilities can provide practical training opportunities and help develop the skills base industry needs.	In the short term, increased demand may intensify existing talent shortages
Dependencies and openness	Measures can support diversification and trusted partnerships, thereby strengthening resilience.	Reporting requirements or restrictions may impose additional burdens on firms and reduce beneficial international cooperation.

Table 8.12. *Trade-offs and synergies breakdown*

51. UNCERTAINTY AND DATA LIMITATIONS

The estimates remain sensitive to the final legal drafting, the number and configuration of supported activities, Member State and stakeholder participation, future programme resources, the frequency and scope of information requests, technological maturity, private-investor and buyer response, and the extent to which existing data and administrative systems can be reused.

Low, central and high assumptions and deterministic sensitivity analysis are used to test the monetary results. These ranges are not statistical confidence intervals. A probabilistic analysis of the same ranges (Annex 4, Table 4.30) shows that, because the ranges are skewed upwards, most sampled outcomes lie above the central estimates; since the ranges are judgement bands rather than calibrated probabilities, this describes the spread of the assumptions rather than a likelihood of cost overrun. The dispersion is concentrated in the marginal service and adaptation assumptions and, for PO3, in the population subject to the quantum-safe preparedness duties. They represent alternative implementation and cost conditions. The central infrastructure case assumes reuse of existing facilities; separate low, high and full-build stress cases test the effect of different marginal service and adaptation assumptions.

Uncertainty	Impacts affected	Treatment
Technology maturity and timing	Industrialisation, procurement, standards and quantum-safe deployment	Maturity scenarios; qualitative assessment where timing cannot be forecast
Future programme resources	Hubs, projects, finance, procurement, employment and territorial impacts	Programme expenditure reported separately; implementation conditional on future legal and budgetary decisions
Participation and utilisation	Coordination, Centres, facilities and voluntary activities	Low, central and high take-up and utilisation assumptions
Private-investment mobilisation	Scale-up finance and firm growth	Illustrative ranges rather than point forecasts
Procurement pipeline and price premium	Demand, supplier revenue and public cost	Alternative pipeline, affected share and premium assumptions

Avoided disruption and security losses	Resilience and quantum-safe preparedness	Low-confidence scenarios; not included in the central ranking
Administrative and implementation costs	Efficiency and burden distribution	Alternative populations, frequencies, time requirements and unit costs
Strength of the baseline	Additionality of all options	Stronger- and weaker-baseline scenarios

Table 8.13. *Principal uncertainties and analytical treatment*

Specific objective	PO1	PO2	PO3
SO-A – Coordination and delivery	+	++	+++
SO-B – Lab-to-fab and infrastructure access	+	++	+++
SO-C – Scale-up finance	+	++	+++
SO-D – Demand and first buyers	+	++	++
SO-E – Skills and user support	+	++	++
SO-F – Trusted and quantum-safe deployment	+	++	+++
SO-G – Dependencies and resilience	+	++	+++

Table 8.14. *Relative effectiveness by specific objective. + limited; ++ substantial; +++ highest formal coverage*

Option	Weighted score	Rank
PO1	3.000	3
PO2	3.438	1
PO3	3.188	2

Table 8.15. *Central multi-criteria results*

(The MCDA results are described in more details in **Table 4.32** and **Table 4.33**)

PO2 ranks first under the balanced central weighting. PO3 may rank first where substantially greater weight is placed on resilience and formal coverage. PO1 ranks best on partial monetized cost because it is the least intensive option, but it does not address all residual gaps. The preferred option therefore reflects a balanced judgement across effectiveness, efficiency, coherence, proportionality, feasibility and uncertainty.

Wider impact	Potential benefits and risks	Relevance for the option assessment
Impacts on S&T excellence, innovation and industrial competitiveness	Benefits: Technology maturation, new products, firm growth and stronger EU value chains. Risks: premature concentration; and, ineffective expenditure.	PO1 improves coordination. PO2 creates a connected research-to-deployment pathway. PO3 strengthens selected finance and procurement measures but does not automatically generate greater benefits.
Societal, employment and public services impacts	Benefits: Potential improvements in health, navigation, monitoring, secure services and high-skilled employment. Risks: unequal access to emerging high-skilled employment opportunities; geographical concentration of jobs and expertise in already strong quantum ecosystems; and persistent shortages of specialised skills. ~~unequal access; concentration and skills shortages.~~	PO1 improves awareness. PO2 links skills, user support and deployment. PO3 retains the same skills and user-support arrangements as PO2; additional effects would be indirect.

Security, resilience and fundamental rights impacts	Benefits: PQC and secure communications could strengthen cybersecurity and improve resilience against future quantum-enabled threats. Risks: Sensing and dual-use applications may give rise to privacy risks, misuse and broader security concerns. Other risks include compliance burdens, administrative costs and potential risks rights and freedoms, depending on implementation.	The PQC transition is mainly part of the baseline. PO1 adds no PQC-specific measure beyond that baseline. PO2 adds a biennial preparedness assessment, coordinated exercises, PQC requirements in public procurement and structured QSB–NIS Cooperation Group cooperation. PO3: PO2 structured PQC cooperation supplemented by binding implementation of the existing PQC roadmap through time-bound migration requirements.
Environmental, energy and resource impacts	Benefits: for energy, advanced materials and environmental monitoring. Direct impacts include energy, cooling, materials and equipment waste. Risks: increased electricity and cooling demand, use of specialised materials and generation of electronic and industrial waste from additional infrastructure and equipment.	PO1 has limited direct effects. PO2 may support selected shared capacity, which could increase direct infrastructure-related impacts. PO3 has the same central infrastructure configuration as PO2; any additional effects would depend on separate funding decisions, rather than the option itself.

Table 8.16. *Wider Impacts*

52. OVERALL CONCLUSION

PO1 has the lowest cost and burden but remains vulnerable to incomplete participation and leaves significant delivery gaps. PO3 provides the highest formal coverage for several objectives but entails the highest societal cost, public-budget impact, administrative capacity needs and risks of market restriction, duplication and premature technology lock-in.

PO2 provides the best overall balance. It creates durable coordination and research-to-deployment pathways, improves access, finance and demand, and introduces targeted standards, quantum-safe and dependency measures while limiting obligations to defined actors and activities. Its success depends on effective use of existing bodies, adequate future program resources, transparent selection, high facility utilization, private additionality, proportionate information requests and continuous simplification.

ANNEX 9: COHERENCE WITH EXISTING EU LEGISLATION AND INITIATIVES (ACQUIS MAPPING)

53. PURPOSE AND SCOPE

This annex assesses the coherence of the proposed EU Quantum Act with the principal Union legislative, policy, funding and implementation frameworks relevant to quantum technologies. It supports the coherence assessment in Chapter 7 of the Main Report and explains how the final PM1–PM16 architecture would complement existing instruments without duplicating their legal, financial, programme-management, procurement, standardisation, cybersecurity, investment-screening or enforcement functions.

The quantitative analytical cut-off is 19 July 2026. For the purposes of coherence and additionality, this Annex also takes account qualitatively of relevant initiatives proposed or adopted up to 30 September 2026. It takes account in particular of Council Regulation (EU) 2026/150 amending the EuroHPC Regulation, Regulation (EU) 2026/1386 on the screening of foreign investments in the Union and the Commission proposal for the Chips Act 2.0, the Cloud and AI Development Act, the EU Inc. Corporate legal framework, the European Innovation Act and the Public Procurement Act. Pending initiatives, including the European Research Area Act and the revision of the European Standardisation Regulation, are considered where relevant to future coherence but are not treated as applicable acquis.

54. PRINCIPLES GOVERNING COHERENCE AND ADDITIONALITY

1. The Quantum Act would address residual coordination and delivery gaps identified against the dynamic baseline. It would not attribute to the Act activities, expenditure or outcomes that would occur under existing Union or Member State instruments.
2. Existing competent bodies and instruments would be used wherever they can perform the required function. The Act would create new structures only where a specific coordination or delivery gap cannot be addressed proportionately through an existing body.
3. The Quantum Strategy Board would provide ecosystem-level strategic review and EU–Member State coordination. It would not replace the statutory programming, procurement, infrastructure or funding functions of EuroHPC, the Chips Joint Undertaking, the Commission, financial institutions or Member State authorities.
4. The European Quantum Alliance would be a light stakeholder interface. It would not duplicate the formal advisory functions of EuroHPC bodies or exercise funding, certification, procurement or enforcement powers.
5. Strategic Project designation would recognise European relevance and facilitate coordination. It would not create an automatic entitlement to funding, State-aid approval, procurement preference, regulatory exemption or priority access.
6. Existing facilities would be mapped, networked and used before additional capacity is supported. New or upgraded capacity would require evidence of a European capability gap, unmet demand, cross-border added value, expected utilisation and operational sustainability.
7. Investment decisions would remain with the EIC, InvestEU, the EIB Group, national promotional institutions and other competent financial bodies under their own legal, governance, risk and additionality rules.
8. Procurement support would preserve the responsibilities of contracting authorities. Any security, resilience, participation or sourcing conditions would require prior market analysis and case-specific justification under applicable Union and international rules.

9. Formal standards would continue to be developed through the recognized European and international standardization system. The Act would not create a parallel standards body.
10. Under PO2, PQC and quantum-safe preparedness would be addressed through a biennial EU preparedness assessment based on information from Member States and Union entities, coordinated exercises and PQC requirements in public procurement, together with structured cooperation between the Quantum Strategy Board and the NIS Cooperation Group, providing regular exchange, coordination and monitoring of implementation of the existing PQC roadmap. The assessment and exercises use existing cybersecurity structures and reporting channels. Under PO3, defined critical public authorities and, where justified, critical operators would be subject to binding roadmap-implementation duties through existing competent cybersecurity authorities.
11. Information requests would be necessary, proportionate, risk-based and limited to information unavailable from existing sources. Common definitions, interoperable formats, data minimization and once-only reuse would apply across the package.
12. International cooperation would remain open and criteria-based. Stronger participation or security conditions would be limited to clearly defined sensitive or strategic contexts and would respect the Union's international commitments.

55. DETAILED COHERENCE AND NON-DUPLICATION MAPPING

Instrument or initiative	Residual issue	Quantum Act complement	Non duplication safeguard
Quantum Europe Strategy, COM(2025) 363 final	Political direction but no durable common implementation cycle or complete delivery framework	PM1–PM16 operationalise selected actions through coordination and delivery pathways	The Act implements the Strategy; priorities remain periodically reviewable
EuroHPC Regulation, Regulation (EU) 2021/1173 as amended by Council Regulation (EU) 2026/150	Broad quantum implementation mandate, but not complete alignment of all national strategies, budgets or external policy functions	PM1–PM7, PM9, PM11 and PM14–PM16 may structure ecosystem-level coordination and feed implementation	EuroHPC retains statutory programming, procurement, infrastructure and funding functions
EuroHPC Quantum Technologies Advisory Group	Formal advice on EuroHPC quantum activities	PM16 provides a wider light interface across users, finance, procurement, standards and value chains	Alliance outputs are routed to the competent formal body
Horizon Europe and successor R&I instruments	Excellent and collaborative R&I	PM2–PM3 connect research to common priorities, milestones and later maturation	Programme excellence, eligibility and financial rules remain unchanged
Digital Europe Programme	Deployment, strategic digital capacities and skills	PM6 and PM9 improve user access, training and deployment support	Programme authorities retain selection and funding responsibility

European Chips Act, Chips JU and the pending Chips Act 2.0 proposal	Semiconductor design, pilot lines, capacity, demand and resilience	PM4–PM6 connect quantum systems, photonics, cryogenics, control, software and users to Chips-supported capabilities	Quantum-chip fabrication and semiconductor pilot lines remain under Chips JU; pending proposal is not treated as applicable acquis
Cloud and AI Development Act	Cloud and AI infrastructure and capacity	PM4–PM6 connect quantum testing, integration and deployment with relevant cloud and AI infrastructures	Cloud and AI infrastructure governance, funding and regulatory functions remain under the relevant framework
EuroQCI, CEF and IRIS²	Secure-connectivity infrastructure and deployment	PM4–PM6, PM8, PM7, PM11 and PM14 support access, testing, interoperability, users and resilient supply	Infrastructure governance, security accreditation and procurement remain under the relevant instruments
EIC, InvestEU and EIB Group	Grants, equity, guarantees, debt and project finance	PM5 and the Quantum Investment Service Desk improve project preparation, referrals, syndication, financing continuity and, where justified, European co-investment or coordinated counteroffers concerning strategic capabilities.	Financial institutions retain independent due diligence and decisions
STEP and proposed European Competitiveness Fund	Visibility and potential financing of strategic technologies	PM5 identifies and prepares relevant quantum projects	Quantum designation remains legally separate from STEP, ECF or equivalent status
European Defence Fund and defence instruments	Defence R&I and capability development	PM2–PM5, PM7, PM9, PM11 PM15 and PM14 may improve civilian-security interfaces	Defence eligibility, ownership, security and funding rules remain fully applicable
Procurement Directives and Financial Regulation	Equal treatment, transparency, competition and procedural rules	PM7 provides buyer coordination, functional specifications, PCP/PPI and reference deployment	Contracting authorities retain award responsibility; any conditions are necessary and proportionate
State-aid and competition rules	Govern public support, cooperation and market conduct	PM5 coordinates projects and funding pathways; PM7 and PM10 improve finance and demand preparation	Designation does not constitute State-aid approval or displace competition assessment

European standardisation framework, Regulation (EU) No 1025/2012	Formal European standardisation procedures	PM8 supports roadmaps, pre-standardisation, benchmarks and testing references	CEN, CENELEC, ETSI and international bodies retain formal standard-setting functions
NIS2 Directive	Technology-neutral cybersecurity risk management and reporting	PM13 provides quantum-specific technical advice and implementation support	NIS2 authorities retain supervision and enforcement; no duplicate reporting
Cybersecurity Act	ENISA and European cybersecurity certification framework	PM8 and PM13 support technical preparation and reference applicable schemes	No competing horizontal Quantum Act certification regime
Cyber Resilience Act	Cybersecurity requirements for products with digital elements	PM13 coordinates quantum-safe implementation support	Product obligations remain governed by the CRA; duplicate documentation is avoided
PQC Recommendation (EU) 2024/1101 and coordinated roadmap	Common direction, milestones and technical basis for PQC transition	PM13b establishes structured cooperation between the QSB and the NIS Cooperation Group for regular exchange, coordination and monitoring of implementation of the existing roadmap; the biennial preparedness assessment and exercises build on the roadmap milestones and reuse existing reporting.	No competing algorithms or parallel cybersecurity regime. PO3-specific duties would be targeted, risk-based, aligned with the existing roadmap and implemented through existing competent authorities.
Economic Security Strategy and Recommendation (EU) 2023/2113	Risk-based framework for technology security, leakage and resilience	PM11 supplies quantum-specific technical mapping and early warning	The Act provides evidence and mitigation support, not a parallel risk-assessment regime
FDI Screening Regulations (EU) 2019/452 and (EU) 2026/1386	Transaction-specific screening on security or public-order grounds	PM11 may provide aggregated technical information to competent authorities	No Quantum Act notification, authorisation, statutory matching or step-in mechanism. The Quantum Investment Service Desk may facilitate voluntary European co-investment or coordinated counteroffers without affecting the competent authority's FDI-screening decision.

Dual-use Regulation (EU) 2021/821	Export, brokering, technical assistance and transfer controls	PM11 maps import-side dependencies and resilience needs	Classification, authorisation and enforcement remain under export-control law
Critical Raw Materials Act	Secure and sustainable supply of listed materials	PM11 covers quantum-specific manufactured components, equipment, software and services outside the material scope	Quantum-specific manufactured components not covered by the CRMA material framework are complemented
Foreign Subsidies Regulation	Addresses distortions caused by foreign subsidies	PM5 and PM7 may identify projects or procurements relevant to the wider framework	Commission powers and notification procedures remain unchanged
GDPR, Trade Secrets Directive and Data Act	Personal data, confidential business information and lawful data use	PM11–PM12 use minimisation, aggregation, access controls and purpose separation	Appropriate legal basis, confidentiality and procedural rights apply
EU Inc. corporate legal framework	Optional EU-wide corporate framework facilitating company establishment and cross-border scale-up	PM4–PM7 and PM10 address quantum-specific scale-up needs through infrastructure access, industrialisation, deployment, procurement and finance	Company formation, corporate governance and company-law requirements remain under the EU Inc. framework and applicable company law
European Innovation Act	Horizontal framework conditions for innovation, including innovation procurement	PM7 addresses quantum-specific innovation procurement and first-deployment needs	Horizontal innovation and innovation-procurement rules remain under the European Innovation Act; no parallel framework is created
Public Procurement Act	Horizontal rules for public contracts and concessions	PM7 supports quantum-specific buyer coordination, PCP/PPI and reference deployment	Procurement procedures and award responsibilities remain under the horizontal procurement framework and with contracting authorities
European Research Area Act	Horizontal coordination of Union and national R&I policies and investment, researcher mobility and knowledge circulation	PM1–PM3 and PM9 provide quantum-specific programming, scientific cooperation, Grand Challenges and skills coordination	Horizontal R&I coordination, mobility and knowledge-circulation functions remain under the ERA framework

Table 9.1. *Detailed coherence and non-duplication mapping.*

56. COMPARISON BETWEEN THE QUANTUM EUROPE STRATEGY ACTIONS AND THE QUANTUM ACT MEASURES

Quantum Europe Strategy Actions Summary	Quantum Act measures
Area 1: Quantum Research and Innovation Initiative	
• Amend EuroHPC JU Regulation to extend its remit to all quantum technologies and, as a first step, transfer present Horizon Europe R&I quantum activities into the JU • Present the Quantum Act proposal • Pilot two Quantum Grand Challenges (Fault-Tolerant Quantum Computing and Quantum PNT systems)	PM2, PM3
Area 2: Quantum Europe Infrastructures	
• Publish EU Quantum Computing and Simulation Roadmap • Expand the number and capacity of EuroHPC-based quantum computing systems • Set up a monitoring framework for quantum computing • Deploy the first EU-interconnected experimental quantum terrestrial and space secure communication network • Publish a Quantum Communication Roadmap • Launch a pilot facility for the European Quantum Internet • Deploy a distributed system of gravimeters across Europe • Publish a Quantum Sensing Roadmap • Establish a European Q-MRI Pilot Infrastructure and scale it up across Europe	PM4, PM5
Area 3: The Quantum Europe ecosystem	
• Establish six new quantum pilot production lines under the Chips Joint Undertaking • Launch a quantum design facility • Release a Quantum Chips Industrialisation Roadmap • Publish a European Quantum Standards Roadmap • Expand the network of quantum competence clusters • Carry out and finalise EU-wide assessments of supply chain vulnerabilities	PM1, PM6, PM7, PM8, PM10, PM11, PM12, PM15, PM16
Area 4: Space & Dual Use Potential Quantum Technologies (Security & Defence)	
• Sign a cooperation agreement with ESA for the development of a Quantum Technology Roadmap in space • Develop a quantum sensing space & defence technology roadmap • Contribute to the European Armament Technological Roadmap • Launch spin-in initiatives to bring-in civil companies and academia for defence applications	PM1, PM3 and PM5, where relevant. Defence- and space-specific actions remain under the relevant Union instruments and competent authorities.
Area 5: Quantum Skills	
• Establish the European Quantum Skills Academy • Launch European Advanced Digital Skills Competitions in quantum • Launch a Pilot Programme on Researcher-in-Residence in Quantum technology startups • Launch the European Quantum Mobility Programme	PM9, PM15
International Cooperation	
• Launch bilateral and multilateral cooperation initiatives	PM 14

• Work with the Member States to establish European Quantum International Cooperation Framework	

Table 9.2. *Table comparing the Strategy's actions with the Act's measures*

57. INTERFACES REQUIRING COORDINATED IMPLEMENTATION

Governance and EuroHPC. The Quantum Strategy Board should review ecosystem-level priorities, national chapters, capability gaps, Strategic Projects and resilience findings. It should not approve EuroHPC work programmes, procurement or infrastructure operations. Recommendations should be transmitted to the competent body for decision.

Research, Grand Challenges and infrastructure. PM2–PM6 should form a continuous but non-automatic pathway. Success in research or a Grand Challenge should not guarantee infrastructure access, designation, funding or procurement. Existing capacity must be assessed before new capacity is financed, and reporting must distinguish scientific, maturation and user-support functions.

Pilot lines, Strategic Projects and finance. PM5 should improve coordination and project preparation without prejudging the decisions of programmes, financial institutions, State-aid authorities or contracting authorities. Under PO3, a dedicated quantum investment mandate or capacity would operate within an existing or future financial instrument rather than creating a new stand-alone institution. Its implementation would require clear governance, additionality, risk-sharing and budgetary arrangements.

Procurement. PM7 should use functional requirements, staged competition and multiple suppliers where feasible. A Grand Challenge or Strategic Project must not automatically determine a subsequent procurement winner. Any preference, eligibility or security condition must be justified by the market and sensitivity of the use case.

Standards, assurance and sandboxes. PM8 may support benchmarks, test methods, interoperability profiles and certification-readiness. Formal standards remain voluntary unless incorporated into a separate legal requirement. Regulatory experimentation must be undertaken with the competent sectoral authority and cannot suspend applicable law without an existing legal basis.

PQC and cybersecurity. Under PO2, the preparedness assessment, coordinated exercises and PQC requirements in public procurement are organised with the NIS Cooperation Group and the competent authorities, without creating a parallel cybersecurity regime. Under PO3, defined critical public authorities and operators would additionally be subject to targeted preparedness duties implemented through the existing competent authorities.

Dependencies and economic security. PM11 may support supplier diversification, qualification of alternatives and contingency planning. Screening, export-control, competition, State-aid, foreign-subsidy and procurement decisions remain with the competent authorities.

Business Platform and data governance. PM12 is voluntary. Information submitted for commercial matchmaking must not automatically be repurposed for regulatory or economic-security action. Mandatory requests under PM11 require a separate lawful purpose, transparency and safeguards.

58. INTERNAL-MARKET COHERENCE AND LEGAL-BASIS IMPLICATIONS

The predominant objective and content of the retained package concern the competitiveness and resilience of the Union's quantum-technology industrial ecosystem. Article 173(3) TFEU therefore constitutes the principal legal basis for the current package. Article 114 TFEU constitutes only for clearly separable provisions approximating national rules where

concrete or likely internal-market obstacles or appreciable distortions of competition are demonstrated.

Any provision based on Article 114 should identify:

- the existing or likely divergent national rules concerned;
- the concrete obstacle to cross-border trade or appreciable distortion of competition;
- the products, services and actors affected;
- why mutual recognition, programme conditions or voluntary coordination are insufficient; and
- why the proposed harmonisation is necessary and proportionate.

Where this evidence is not available, the relevant measure should remain an industrial-policy, research, programme, procurement, funding or voluntary-standardisation measure. The final legal basis and provision-by-provision justification remain subject to Legal Service confirmation.

59. OVERALL CONCLUSION

The preferred option is coherent with the Union acquis and current initiatives provided that it operates as a connecting and delivery framework rather than a parallel programme or regulatory system. Its added value lies in common strategic review, continuity between research and deployment, structured project, finance and procurement pathways, user support, shared technical references, quantum-safe coordination and targeted dependency intelligence.

Coherence depends on respecting the statutory mandates of EuroHPC, the Chips JU, programme authorities, financial institutions, cybersecurity and economic-security authorities and contracting authorities; avoiding automatic benefits from designation; reusing existing structures and data; and limiting stronger requirements to mature, clearly defined and objectively justified contexts.

Intervention dimension	PO1 – Voluntary horizontal framework	PO2 – Enabling Quantum Framework Act	PO3 – High-intensity targeted framework
Overall approach	Non-legislative, voluntary and market-enabling. No new mandatory requirements.	Targeted legislative framework establishing structured EU–Member State governance and delivery arrangements, mainly through existing bodies.	Retains PO2 architecture but applies higher-intensity variants to a limited number of measures.
R&I excellence	Voluntary EU–Member State coordination, research networking and alignment on common priorities and challenges (PM1–PM3).	Common programming framework, European Quantum S&T Excellence Network and competitively selected, milestone-based Grand Challenges (PM1–PM3).	Same as PO2.
Industrialisation, deployment and demand	Voluntary access and user-support arrangements, investment-readiness support, skills coordination, pre-standardisation and buyer cooperation (PM4–PM10).	Technology and Innovation Hubs, Strategic European Quantum Infrastructures and large-scale Quantum Projects , Competence and Acceleration Centres, innovation procurement, standards and benchmarking, skills and mobility, and structured access to financing (PM4–PM10).	Same architecture as PO2, with stronger variants for investment capacity and selected strategic procurement condition.

Security and resilience	Voluntary dependency information and dashboard, business matchmaking, technical quantum-safe exchange and existing international cooperation (PM11–PM14).	Risk-based dependency mapping and early warning, voluntary Business Platform, quantum-safe preparedness (assessment, exercises, procurement requirements and implementation support) and strategic international cooperation (PM11–PM14).	PO2 support architecture with wider information requirements for defined critical dependency categories; other measures remain as under PO2.
Governance and delivery	Voluntary cooperation and informal coordination.	Quantum Strategy Board and European Quantum Alliance; implementation principally through existing competent Union and national bodies (PM15–PM16).	Same governance and delivery architecture as PO2.

Table 9.3. *Comparative summary of the policy options*

ANNEX 10: MONITORING AND EVALUATION FRAMEWORK

60. PURPOSE AND INTERVENTION LOGIC

This annex sets out the monitoring and evaluation framework for the preferred option. The core indicators also provide the basis for assessing the added value of PO2 compared with the dynamic baseline. It operationalises the intervention logic established in the Main Report: problem drivers → problems → specific objectives → policy measures → outputs → results → impacts.

The framework serves four purposes:

- to monitor whether the measures established or enabled by the Quantum Act are implemented as intended;
- to assess whether they improve the functioning and performance of the European quantum ecosystem;
- to support evidence-based adjustment, continuation, scaling, simplification or termination of measures; and
- to provide the evidence required for the evaluation of the initiative.

Monitoring will begin from the date of application. The principal policy horizon is 2030. Costs, burdens and implementation resources will be monitored over the 2028–2037 assessment period, while longer-term trends may be examined up to 2035 or later where data are reliable.

The framework distinguishes output indicators, result indicators and impact indicators. It does not assume that all observed changes can be attributed to the Quantum Act. Technological breakthroughs, macroeconomic conditions, national investment, other Union instruments and international developments will also affect outcomes.

61. MONITORING PRINCIPLES

Principle	Operational meaning
Reuse before new collection	Reuse information held by Union bodies, Member States, programmes, financial institutions, infrastructure operators and competent authorities wherever lawful and technically possible.
Proportionality	Match frequency and granularity to the measure, public support, strategic role, sensitivity, maturity, risk and administrative capacity of the reporting actor.
Annual reporting as default	Use more frequent reporting only for project milestones or defined early-warning situations.
Monitoring by function	Record scientific excellence, technology maturation and user-support functions separately even where one organisation performs more than one function.
Outcome orientation	Track progression, access, finance, customers, utilisation, skills and mitigation, not only expenditure, meetings or designations.
Technology and maturity differentiation	Disaggregate computing and simulation, communication, sensing and metrology and enabling technologies where materially different.
Confidentiality and security	Use aggregation, anonymisation, restricted access and secure systems for commercially or security-sensitive information.
Adaptive implementation	Simplify, revise or discontinue indicators and measures that do not provide proportionate analytical or operational value.
No duplicate reporting	Apply common definitions, interoperable formats, pre-filled forms and once-only reuse across PM1–PM16.

Table 10.1. *Monitoring principles.*

62. GOVERNANCE AND MONITORING CYCLE

The Commission will have overall responsibility for monitoring implementation and impacts. Member States will provide structured inputs through national quantum chapters

and the Quantum Strategy Board. EuroHPC JU, the Chips JU and other implementing bodies will provide programme, project, facility and infrastructure data. Financial institutions will provide aggregated pipeline, operation and private-mobilisation data. Public buyers, supported projects, Strategic Projects, infrastructure operators, standards and testing bodies, ENISA and relevant cybersecurity structures will contribute through existing or proportionate reporting channels.

The Quantum Strategy Board will review implementation strategically. It will not replace programme management, statutory monitoring, supervision or enforcement assigned to other bodies. The European Quantum Alliance may provide stakeholder feedback but will not validate official results.

Monitoring product	Timing	Principal content	Responsibility
Initial baseline and indicator dictionary	Within six months of application	Definitions, populations, data owners, sources, baselines, milestones, confidentiality and cost of collection	Commission with Member States and implementing bodies
Annual implementation dashboard	Annually	Stable core indicators, outputs, costs, burdens, participation, access, finance, procurement and risk findings	Commission
National quantum chapters/review	At least annually or as defined in the Act	National priorities, programmes, investments, infrastructures, milestones and implementation issues	Member States and Commission
Thematic reviews	As needed, normally every two years	Infrastructure utilisation, finance additionality, procurement conversion, standards uptake, skills, dependencies or burden	Commission and relevant competent bodies
Mid-course implementation review	Approximately three years after application	Operational effectiveness, burden, utilisation, duplication and need for adaptation	Commission and Quantum Strategy Board
Comprehensive evaluation	Five years after entry into force	Effectiveness, efficiency, coherence, EU added value, proportionality and continued relevance	Commission, supported by independent evaluation where appropriate

Table 10.2. *Monitoring and evaluation cycle*

63. CORE INDICATORS BY SPECIFIC OBJECTIVE

Objective	Core indicators	Baseline	2030 milestone or direction	Source/frequency
SO-A – Coordination and delivery	National chapters submitted and updated; common reviews completed; recommendations followed up; identified gaps or overlaps addressed	Fourteen Member States had strategies and four were preparing one; no common Union review cycle	Chapters from all Member States; regular review and dashboard; findings addressed or explained	Commission, Member States and programme data; annual
SO-B – Lab-to-fab and infrastructure access	Facilities participating; users supported; SME and cross-border use; utilisation; waiting times; progression to validation or qualification	91 testbeds and 27 pilot lines mapped; 18 testbeds and eight pilot lines identified as open to start-ups	Supported facilities publish access and utilisation information; SME and cross-border use increases; waiting and validation times decrease	EuroHPC, Chips JU, facilities and access systems; annual

SO-C – Scale-up finance	Firms referred and financed; public and private capital mobilised; follow-on rounds; cross-border syndication; firms reaching scale indicators	EU firms under-represented in mapped rounds above EUR 25m; fragmented financing pathways	Increased participation in later-stage rounds, cross-border finance and private co-investment; continuity improves	EIC, InvestEU, EIB/EIF, national institutions and market data; annual
SO-D – Demand and first buyers	PCP/PPI actions; reference deployments; pilots progressing to follow-on or repeat procurement; buyer number and diversity	32 computing procurement schemes, 52 communication deployments and one microsatellite initiative mapped; no systematic conversion baseline	Conversion baseline established in first cycle; increasing share progresses to reference or repeat procurement	Public buyers, procurement systems and supported projects; annual
SO-E – Skills and user support	People trained; placements and mobility; user organisations supported; vacancy and skills-gap indicators; participation by sex where available	Around 40 specialised master's programmes; no harmonised Union skills-gap or user-capability baseline	Common baseline established; participation and completion increase; supported activities include relevant skills or user-capability measures	Programmes, training providers, employers and surveys; annual/biennial
SO-F – Trusted and quantum-safe deployment	Benchmarks, testing methods and specifications developed and used; voluntary assurance activities; structured PQC cooperation between the Commission, Member States and relevant bodies and participation; biennial PQC preparedness assessments completed; Member States providing information and taking part in exercises; public procurement procedures applying PQC requirements	165 standardisation items mapped, around 30% published formal standards; coordinated PQC roadmap in place	Increasing use of common methods in mature areas; structured QSB–NIS Cooperation Group cooperation operational, with broad Member State participation; biennal PQC preparedness assessments completed (the first by the end of 2028 and coordinated exercises held.	Standards bodies, testing organisations, ENISA and Member State channels; annual
SO-G – Dependencies and resilience	Critical inputs assessed; alternatives qualified; mitigation actions initiated; substitution time and disruption delays	47 inputs mapped; nine without an identified EU supplier; alternative sourcing weaker at sub-component level	Listed inputs periodically reviewed; mitigation for high-risk dependencies; alternatives increase and delays decrease	Strategic-intelligence system, programmes and restricted evidence; annual or risk-triggered

Table 10.3. *Core indicators by specific objective*

64. OPERATIONAL INDICATORS BY POLICY MEASURE

Policy measure	Principal implementation and early-result indicators	Data owner	Frequency
PM1 – Common programming framework	National chapters; common priorities; overlaps/gaps identified and addressed; time to follow-up	Commission and Member States	Annual
PM2 – Quantum Science and Technology (S&T) Excellence Network	Participating organisations and Member States; joint priorities; mobility; progression to later support	Research programmes and network	Annual
PM3 – Quantum Grand Challenges	Calls, participants, milestones achieved, continuation/stop decisions and outputs progressing to validation	Implementing programme	Per milestone and annual
PM4 – Technology and Innovation Hubs	Facilities, service catalogues, access requests, waiting time, utilisation, SME and cross-border use	Facility operators and access systems	Annual
PM5 – Strategic Quantum Infrastructuress and Strategic Quantum Projects	Applications, designations, processing time, milestones, review decisions, finance and procurement follow-up	Commission and project promoters	Annual/per milestone
PM6 – Competence and Acceleration Centres	Users supported, referrals, use cases, training, satisfaction and progression to facilities, finance or buyers	Centre operators	Annual
PM7 – Innovation Procurement	Buyer groups, PCP/PPI, suppliers, reference deployments, follow-on procurement, cycle time and price premium	Public buyers	Annual
PM8 – Standards, benchmarking and assurance	Roadmaps, work items, benchmarks, testing methods, use in projects/procurement and repeated testing avoided	Standards and testing bodies	Annual
PM9 – Skills and mobility	Training actions, participants, completion, placement, mobility, vacancy indicators and user capability	Programmes and providers	Annual/biennial
PM10 – Quantum Investment Service Desk	Firms advised and referred; investment-readiness support provided; referrals resulting in financing; follow-on investment; time from referral to financing decision.	Financial institutions	Annual
PM11 – Strategic intelligence and dependency monitoring	Categories mapped, requests, response burden, alerts, mitigation, alternatives and disruption duration	Commission and competent bodies	Annual/risk-triggered
PM12 – Quantum Business Platform	Users, matches, opportunities, investment/user contacts, satisfaction and data-quality indicators	Platform operator	Annual
PM13 – Quantum-safe preparedness	Structured PQC cooperation between the Commission, Member States and relevant bodies, participation and evidence on implementation of the existing PQC roadmap; preparedness assessments published (the first by the end of 2028), exercises held and Member States taking part; procurement procedures applying PQC requirements.	Commission, ENISA and relevant bodies	Annual
PM14 – Strategic international cooperation	Partnerships, reciprocity, participation, joint standards/research/supply actions and safeguards	Commission and programme bodies	Annual

PM15 – Quantum Strategy Board	Board established; meetings and reviews; recommendations; implementation follow-up	Commission and Board secretariat	Annual
PM16 – European Quantum Alliance	Membership and balance; meetings; contributions used; stakeholder satisfaction	Alliance secretariat	Annual

Table 10.4. *Operational indicators by final policy measure*

65. HORIZONTAL INDICATORS

Dimension	Indicators
SMEs and start-ups	Applicants, users, beneficiaries, success rates, finance, procurement, waiting time and burden by micro, small and medium-sized enterprise
Territorial distribution	Participation and benefits by Member State and region; cross-border access; concentration of support and facilities
Competition and market structure	Supplier and beneficiary concentration, number of suppliers retained, new entrants and use of proprietary interfaces
Environmental performance	Energy, cooling, water, materials, utilisation and comparison with feasible alternatives where material
Fundamental rights and procedural safeguards	Requests, objections, review, appeals, confidentiality incidents, data-protection issues and processing time
Administrative burden and simplification	Actual staff time and cost by actor; reporting cycles and fields; reused data; duplicate requests avoided; SME burden; deviation from ex ante assumptions
International cooperation	Partnerships, reciprocity or market-access arrangements and participation of partners in relevant projects and procurement
Gender and inclusion	Participation in skills, mobility and relevant actions where reliable and proportionate data are available
Public-budget and staffing	Actual EU and Member State expenditure, transfers, Commission and Member State person-days/FTE and implementing-body resources

Table 10.5. *Horizontal monitoring dimensions*

66. INDICATOR MANAGEMENT AND DATA QUALITY

A common indicator dictionary will be prepared within six months of application. For each indicator it will specify:

- identifier, title and link to the intervention logic and policy measure;
- output, result or impact classification;
- definition, unit, population, scope, baseline and direction of travel;
- data source, data owner, reporting body and frequency;
- validation method and required breakdowns;
- confidentiality classification and retention conditions;
- estimated cost of collection and known limitations; and
- conditions for revision or discontinuation.

Principal quality risks include incomplete coverage, inconsistent definitions, double counting, self-reporting, survivorship bias, unavailable firm-level data, confidentiality restrictions, technology differences and attribution of wider market changes.

These risks will be addressed through common definitions, data reconciliation, audit sampling, methodological transparency, case studies, independent studies and stable time-series metadata. Changes in definitions or population coverage must be documented.

67. DATA GOVERNANCE AND CONFIDENTIALITY

Issue	Safeguard	Practical implementation

Data minimisation	Collect only data necessary for implementation, monitoring or evaluation	Limit fields and populations; apply thresholds and risk-based scope
Reuse and once-only reporting	Reuse information already available	Pre-fill forms and use interoperable templates and lawful data-sharing arrangements
Commercial confidentiality	Protect trade secrets and sensitive business information	Aggregation, restricted access, anonymisation and secure channels
Security-sensitive information	Separate public monitoring from restricted intelligence	Role-based access and secure systems
Personal data	Apply applicable data-protection principles and rules	Purpose limitation, lawful basis, retention limits and impact screening
Data quality	Use common definitions and validation	Indicator dictionary, automated checks, workshops and audit samples
Proportionality	Match reporting to risk, support and actor capacity	Annual default, simplified SME formats and targeted requests
Transparency	Explain methodologies and changes	Public metadata and methodological notes for aggregated indicators
Procedural rights	Allow correction and review where information is used in formal decisions	Notification, right to be heard and review arrangements

Table 10.6. *Data-governance safeguards*

Non-participation in the voluntary Business Platform must not lead to additional regulatory reporting or adverse treatment. Information supplied for commercial matchmaking must not be reused automatically for regulatory or economic-security purposes without an appropriate legal basis and safeguards.

68. COST AND BURDEN MONITORING

Actual implementation costs will be compared with the ex ante central estimates in Annex 4. Monitoring will distinguish administrative burdens, adjustment costs, enforcement and implementation costs, participation costs that are not compliance costs, other real-resource costs, public expenditure, transfers and financing volumes.

For the preferred option, deviations should be examined at least annually. Material increases should trigger analysis of population coverage, reporting frequency, staff time, unit cost, facility utilisation, duplication and whether simplification or narrowing of scope is required.

69. EVALUATION FRAMEWORK

The Commission will carry out a comprehensive evaluation five years after entry into force. The timing should allow the principal governance, access, finance, procurement and monitoring mechanisms to operate while enabling the findings to inform future programming and any amendment of the framework.

Criterion	Principal evaluation questions	Main evidence
Effectiveness	To what extent were SO-A–SO-G achieved? Which measures produced the intended outputs and results? Which causal pathways were supported by evidence?	Monitoring data, program data, surveys, interviews, case studies and comparative analysis
Efficiency	Were costs and burdens proportionate to results? Did actual costs differ from ex ante estimates? Were facilities and support effectively used?	Updated Standard Cost Model, expenditure, staffing, burden and utilization data
Coherence	Did the Act complement EuroHPC JU, Chips JU, programs, cybersecurity and economic-security instruments without duplication?	Acquis mapping, governance records, stakeholder and institutional evidence
EU added value	Which outcomes required Union scale, cross-border access, common intelligence or integrated demand and finance pathways?	National counterfactuals, cross-border participation, case studies

		and comparison with non-supported activity
Relevance	Do the problems and objectives remain material given technological, market and international developments?	Updated problem indicators, market evidence, technology review and stakeholder consultation
Proportionality and rights	Were obligations, information requests, procurement and assurance requirements necessary and proportionate? Were safeguards effective?	Complaints, review decisions, burden data, rights and confidentiality incidents
SME and distributional impacts	How were costs and benefits distributed by firm size, Member State, region, technology domain and actor type?	Disaggregated administrative, finance, access, procurement and skills data
Sustainability and resilience	Did the initiative improve capability, supplier diversity, trusted deployment and continuity without unjustified restriction of openness?	Dependency mapping, disruption cases, standards uptake and international-cooperation evidence

Table 10.7. *Evaluation criteria and questions*

70. EVALUATION DESIGN AND METHODS

The evaluation will use a mixed-method approach, including:

- administrative, programme, firm, investment and procurement data;
- infrastructure-access, waiting-time and utilisation analysis;
- surveys and interviews with firms, users, buyers, researchers, Member States and implementing bodies;
- project, technology and value-chain case studies;
- process tracing and contribution analysis;
- comparison of supported and non-supported firms, projects, facilities or procurements where feasible;
- international comparison;
- updated Standard Cost Model and burden estimates; and
- secure analysis of confidential or security-sensitive evidence.

The evaluation must distinguish the contribution of the Act from general technological progress, macroeconomic developments, national expenditure, other Union programmes and international policy changes. Where direct attribution is not possible, it should assess the plausibility and strength of the initiative's contribution.

71. REVIEW AND ADAPTIVE IMPLEMENTATION

Monitoring and evaluation findings will inform:

- revision of strategic priorities and future Grand Challenges;
- selection, continuation, modification or termination of supported measures;
- Strategic Project designation and review;
- infrastructure-capacity and access decisions;
- finance and procurement pipeline design;
- standards, testing, skills and quantum-safe priorities;
- dependency mitigation and international cooperation;
- simplification of reporting and information requests; and
- possible amendment of the legal or delivery framework.

A measure should be adapted, suspended or terminated where evidence shows that it:

- does not provide sufficient Union added value;

- duplicates another instrument;
- creates disproportionate administrative or compliance costs;
- produces insufficient use or demand;
- distorts competition without adequate justification;
- locks in an immature technology;
- creates unnecessary barriers to cooperation; or
- no longer responds to a material policy need.

Any future consideration of a stand-alone financial vehicle, broader assurance requirements, stronger reporting or additional binding quantum-safe obligations would require updated evidence and, where appropriate, a new impact assessment.

ANNEX 11: SUPPORTING DATA AND ANALYTICAL EVIDENCE

This annex presents selected data and analytical findings from the PPMI/d-fine supporting study and the Joint Research Centre (JRC) analysis used to inform the Impact Assessment.

The evidence is organised by thematic area, covering existing national policy measures, research and innovation, commercialisation and financing, infrastructure accessibility, supply-chain dependencies, public procurement and standardisation.

72. QUANTUM POLICY MEASURES

This section presents an overview of national policy measures supporting the development of quantum technologies across EU Member States, based on the mapping conducted by the supporting PPMI/d-fine study. It covers quantum-specific strategies and initiatives, as well as the distribution of mapped national- and EU-level actions across key quantum technology areas.

Table 11.1 provides an overview of quantum-specific strategies and initiatives adopted or under preparation in EU Member States, including their implementation timelines and associated funding envelopes, where available.

Member State	Title	Timeline	Main funding envelopes (estimations)
A. Adopted quantum-specific strategies and initiatives			
Austria	Quantum Austria Funding Initiative	2021-2026	EUR 107 million
Czechia	National Strategy for Quantum Technologies	2026–2031, to be updated in 2030 for 2031-2036	EUR 192,5 million until 2030
Denmark	National Strategy for Quantum Technologies	2023-2027	EUR 130 million for R&I; EUR 26 million from 2024 to 2027 for Commercialisation & Security
Finland	Finnish Quantum Technology Strategy	2025-2035	Not specified
France	National Acceleration Strategy for Quantum Technologies	2021-2025	EUR 1 billion in state investment; EUR 1.8 billion total
Germany	Quantum Technologies Conceptual Framework Programme of the Federal Government	2024-2026	EUR 2.18 billion; approximately EUR 850 million in complementary research activities
Ireland	National Quantum Technologies Strategy for Ireland	Towards 2030	Not specified
Italy	Italian Strategy on Quantum Technologies	2025-2030	Around EUR 200 million per year for 5 years
Luxembourg	Luxembourg's Quantum Strategy	2025-2030	EUR 100 million in total for strategies for data, AI and quantum

Netherlands	National Agenda for Quantum Technology	Published in 2019	EUR 102 million annually, including EUR 69 million from existing programmes
Romania	National Strategy for Quantum Technologies for the period 2024 - 2029	2024-2029	Not specified
Slovenia	Strategy for the Development of Quantum Technologies in Slovenia	Until 2035	Around EUR 54 million
Spain	Spain Quantum Technologies Strategy	2025-2030	EUR 808 million
	Complementary Quantum Communications Plan	-	EUR 76 million
Sweden	Swedish Quantum Agenda	Published in 2023	Preliminary funding: EUR 4.6 million for 2027, EUR 9.2 million for 2028
B. Quantum-specific strategies and initiatives under preparation			
Bulgaria	Draft Decision of the Council of Ministers for approval of the National Program "Increasing the Capacity in the Field of Quantum Informatics"	2025-2031	EUR 6.2 million (proposed)
Greece	National Quantum Strategy (under preparation)	Towards 2030	Not specified
Poland	Polish Quantum Strategy	Forthcoming; until 2035	EUR 1 billion (proposed)
Slovakia	Strategy for the Development of Quantum Technologies	2027-2035	Not specified

Table 11.1. Overview of quantum strategies and policy initiatives across EU Member States

The funding envelopes associated with these measures vary substantially, although direct comparisons are limited by differences in scope, implementation periods and the availability of quantum-specific funding information.

In addition to the quantum-specific strategies and initiatives presented in Table 11.1, Member States support the development of quantum technologies through broader policy frameworks at national and regional levels, including digitalisation, research and innovation, cybersecurity and industrial strategies. Support is also provided through institutional funding, dedicated projects and programmes. These additional measures are not covered by the overview presented in Table 11.1.

Beyond the mapping of national strategies and initiatives, the supporting PPMI/d-fine study also identifies national- and EU-level actions across four quantum technology areas. Table 11.2 presents the distribution of these mapped actions.

Quantum technology area	National-level actions	EU-level actions
Quantum computing and simulation	92	34
Quantum sensing and metrology	43	18
Quantum communication	24	9
Enabling technologies	11	10

Table 11.2. Number of mapped national- and EU-level actions by technology area

73. RESEARCH AND INNOVATION IN QUANTUM TECHNOLOGIES

This section presents findings from the supporting PPMI/d-fine study on EU-funded research and innovation projects in quantum technologies under Horizon 2020 and Horizon Europe, as well as global patenting trends and the geographical distribution of patent activity across quantum technology platforms.

73.0. EU-FUNDED QUANTUM RESEARCH AND INNOVATION PROJECTS

This subsection presents an overview of EU-funded research and innovation projects in quantum technologies under Horizon 2020 and Horizon Europe. The analysis covers quantum computing and simulation, quantum communication (including quantum key distribution), quantum sensing and metrology, post-quantum cryptography, and key enabling technologies, such as quantum photonics, cryogenics and control electronics. Project-level information was extracted from the European Commission's CORDIS database. Projects were classified according to their EU funding programme and funding scheme, with the latter grouped into low- and high-technology readiness level (TRL) categories. This classification enables an assessment of the number and timelines of projects across different stages of technological development.

Table 11.3 presents the distribution of the identified projects by funding programme, TRL category (Low/High) and completion status (Y/N). In total, 283 projects were identified, of which 200 are classified as low-TRL and 83 as high-TRL.

Count of ID	**Projects**						
	High		**High Total**	**Low**		**Low Total**	**Grand Total**
Completion status	N	Y		N	Y		
H2020	1	17	**18**	2	92	**94**	**112**
ERA-NET-Cofund	1	1	**2**				**2**
IA		1	**1**				**1**
RIA				2	92	**94**	**94**
SME-1		6	**6**				**6**
SME-2		8	**8**				**8**
SME-2b		1	**1**				**1**
HORIZON	38	27	**65**	97	9	**106**	**171**
HORIZON-EIC	11	8	**19**	42	2	**44**	**63**
HORIZON-EIC-ACC	13		**13**				**13**
HORIZON-EIC-ACC-BF	3	19	**22**				**22**
HORIZON-IA	11		**11**				**11**
HORIZON-JU-RIA				5	1	**6**	**6**
HORIZON-RIA				50	6	**56**	**56**
Grand Total	**39**	**44**	**83**	**99**	**101**	**200**	**283**

Table 11.3*. Number of EU-funded projects on quantum technologies by programme, TRL class and completion status*

73.0.1. Start year of EU-funded projects on quantum technologies

Table 11.4 presents the distribution of EU-funded quantum technology projects by start year, funding programme (H2020/HORIZON) and TRL category (Low/High) over the period 2015–2026.

Year	Low TRL			High TRL			Grand Total
	H2020	HORIZON	**TOTAL**	H2020	HORIZON	**TOTAL**	
2015	14		**14**				**14**
2016	4		**4**	2		**2**	**6**
2017	6		**6**	2		**2**	**8**
2018	26		**26**	2		**2**	**28**
2019	13		**13**	4		**4**	**17**
2020	21		**21**	5		**5**	**26**
2021	9		**9**	3		**3**	**12**
2022	1	29	**30**		15	**15**	**45**
2023		29	**29**		20	**20**	**49**
2024		20	**20**		12	**12**	**32**
2025		19	**19**		18	**18**	**37**
2026		9	**9**				**9**
Grand Total	**94**	**106**	**200**	**18**	**65**	**83**	**283**

Table 11.4. *EU-funded quantum technology projects by start year, programme and TRL class*

73.0.2. End year of EU-funded projects on quantum technologies

Table 11.5 presents the distribution of EU-funded quantum technology projects by end year, funding programme (H2020/HORIZON) and TRL category (Low/High) over the period 2017–2032.

Year	Low TRL			High TRL			Grand Total
	H2020	HORIZON	**TOTAL**	H2020	HORIZON	**TOTAL**	
2017	1		**1**	2		**2**	**3**
2018	8		**8**	1		**1**	**9**
2019	7		**7**	4		**4**	**11**
2020	2		**2**				**2**
2021	7		**7**	1		**1**	**8**
2022	27		**27**	4		**4**	**31**
2023	15		**15**	4		**4**	**19**
2024	16		**16**	1	9	**10**	**26**
2025	8	8	**16**		13	**13**	**29**
2026	3	41	**44**	1	22	**23**	**67**
2027		29	**29**		14	**14**	**43**
2028		11	**11**		6	**6**	**17**
2029		10	**10**		1	**1**	**11**
2030		5	**5**				**5**

2031		1	**1**				**1**
2032		1	**1**				**1**
Grand Total	**94**	**106**	**200**	**18**	**65**	**83**	**283**

Table 11.5. *EU-funded quantum technology projects by end year, programme and TRL class*

The share of high-TRL projects among all EU-funded quantum technology projects concluding each year increased from 21% in 2023 to 45% in 2025, indicating progress towards validation and deployment.

73.1. PATENT ACTIVITY IN QUANTUM TECHNOLOGIES

This subsection presents an overview of global patenting activity in quantum technologies, focusing on patent filing trends and the geographical distribution of patent activity across seven technology families: superconducting circuits, trapped ions, neutral atoms, semiconductor-based spin qubits, photonic qubits, diamond/nitrogen-vacancy (NV) centres, and quantum metrology.

The analysis draws on patent data extracted from the European Patent Office's (EPO) Espacenet database[24] using technology-specific keyword searches and Cooperative Patent Classification (CPC) codes[25]. The search results were grouped into patent families, with exclusion filters applied to minimise overlaps between technology categories. The findings were cross-validated, where applicable, against the European Quantum Industry Consortium's (QuIC) 2026 white paper, *A Portrait of the Global Patent Landscape in Quantum Technologies*[26].

The following subsections present the findings of the supporting study, focusing on patent filing trends over time and the geographical distribution of patent activity across quantum technology platforms.

73.1.1. Global evolution of patent filings across quantum technology platforms

Table 11.6 presents the global evolution of patenting activity across seven quantum technology families by earliest priority year, based on findings from the supporting PPMI/d-fine study. The data indicate a substantial increase in patenting activity between 2018 and 2023, with superconducting circuits accounting for the largest number of identified patent families, followed by trapped-ion technologies. While patenting activity increased across most technology families over this period, the scale and pace of growth varied across platforms.

Priority Year	Technology family							Total per year
	Super-conducting	Trapped Ions	Neutral Atoms	Spin Qubits	Photonic Qubits	Diamond / NV	Quantum Metrology	
2018	133	26	6	15	4	23	21	**228**
2019	161	41	7	11	11	36	34	**301**
2020	260	70	29	22	33	44	34	**492**
2021	246	107	33	35	34	60	60	**575**
2022	333	152	48	26	32	56	46	**693**
2023	362	200	46	30	43	86	51	**818**
2024	195	103	21	15	34	49	61	**478**

[24] European Patent Office (EPO), Espacenet – Patent Search.
[25] European Patent Office (EPO), Quantum Technologies – Technology Platform.
[26] QuIC (2026), *A Portrait of the Global Patent Landscape in Quantum Technologies.*

2025	51	7	9	1	7	7	40	**122**
Total per tech	**1741**	**706**	**199**	**155**	**198**	**361**	**347**	

Table 11.6*. Global patent filing trends by earliest priority year and quantum technology platform*

The lower figures recorded for 2024 and 2025 should be interpreted with caution, as recent priority years are affected by patent publication delays and may not yet be fully represented in the available data.

73.1.2. Geographical distribution of patent activity

Table 11.7 presents the geographical distribution of patent activity across quantum technology platforms, highlighting differences in the relative positions of major regions. US applicants account for the largest shares of patenting activity in five of the seven technology families. European applicants lead in semiconductor-based spin qubits and diamond/NV centres, while also maintaining a substantial presence in neutral-atom technologies.

Table 11.7. Patent mapping by technology family and geographical share

Technology Family	Total patents	Europe's share (%)	US share (%)	CN share (%)	JP/KR share (%)	Other (%)
Superconducting circuits	1741	18.8%	56.9%	6.5%	10.1%	7.7%
Trapped ions	706	30.0%	53.2%	4.7%	7.5%	4.5%
Neutral atoms	199	36.8%	48.9%	1.5%	7.8%	5.0%
Semiconductors / spin qubits	155	48.8%	19.1%	1.3%	5.2%	25.6%
Photonics qubits	198	29.3%	41.4%	4.0%	10.7%	14.6%
Diamond / NV centres	361	36.1%	30.6%	2.4%	16.6%	14.2%
Quantum metrology	347	20.3%	49.3%	10.5%	14.7%	5.2%

Geographical shares were calculated based on applicant-country instances, meaning that patents involving applicants from multiple countries may contribute to several geographical categories. For the purposes of the analysis, Europe includes the EU27, the United Kingdom, Switzerland, Norway and Iceland.

74. STANDARDISATION IN QUANTUM TECHNOLOGIES

This section presents findings from the supporting PPMI/d-fine study on standardisation activities in quantum technologies. The study maps 165 standardisation-related items identified through a review of official websites and publications of European and international standardisation organisations, national and regional cybersecurity agencies, industry stakeholders and relevant research initiatives. The analysis covers quantum computing and simulation, quantum sensing and metrology, quantum communication, and post-quantum cryptography, examining the distribution of identified items by entity type, thematic area, activity type and status, as well as the evolution of published standardisation outputs over time.

74.0. STANDARDISATION EFFORTS BY THEMATIC AREA AND STATUS

Tables 11.7 and 11.8 present the distribution of the 165 mapped standardisation-related items. Table 11.8 shows their distribution by entity type and thematic area, while Table 11.9 distinguishes between formal standards, pre-normative standardisation, de facto standardisation and pre-standardisation research and development, according to their respective status.

	All quantum technologies	Quantum Computing & Simulation	Quantum Sensing & Metrology	Quantum Communication	Post-Quantum Cryptography	Hybrid Quantum Communication and PQC	Grand Total
Corporate	1	6			4		**11**
European Research		4	4	4	6	1	**19**
European Standardisation	6	10	4	19	20	3	**62**
Global Standardisation	5	5	2	47	4		**63**
Non-European Standardisation					10		**10**
Grand Total	**12**	**25**	**10**	**70**	**44**	**4**	**165**

Table 11.8. *Standardisation efforts by entity type and thematic pillar*

	Published	Under Drafting	Planned	Concluded	Ongoing	Grand Total
Formal standard	50	25	5			**80**
Pre-normative standardisation/pre-standard	44	4	4			**52**
De-facto standardisation	9				4	**13**
Pre-standardisation R&D				7	13	**20**
Grand Total	**103**	**29**	**9**	**7**	**17**	**165**

Table 11.9. *Standardisation efforts by activity type and status*

74.1. EVOLUTION OF PUBLISHED STANDARDISATION OUTPUTS

Table 11.10 presents the annual number of published standardisation outputs identified in the mapping, including formal standards, pre-standards and de facto standardisation. The data show an increase in published outputs in recent years, particularly in 2024 and 2025. Data for 2026 cover only outputs identified at the time of the study.

Published Year	Count
2010	3
2011	0
2012	0
2013	0
2014	1
2015	0
2016	3
2017	4
2018	3
2019	4
2020	5
2021	7
2022	10
2023	13
2024	22
2025	23
2026	5
Grand Total	**103**

Table 11.10. Published standardisation outputs per year

75. COMMERCIALISATION AND FINANCING OF QUANTUM COMPANIES

This section examines the commercialisation and financing of quantum technology companies, drawing on findings from the JRC and the supporting PPMI/d-fine study. It covers the market availability of quantum technology products, venture capital investment across financing stages, the geographical origin of investors in large funding rounds, and public procurement as a demand-side support mechanism.

75.0. COMMERCIALISATION STATUS OF EU QUANTUM COMPANIES

Tables 11.10 and 11.11 present findings from a JRC analysis conducted in May 2026 on a sample of 140 EU-based quantum technology companies. The analysis examines whether these companies had products available on the market, providing an indication of their commercialisation status. Results are presented by Member State and quantum technology segment.

The findings indicate that approximately 72% of the companies examined had products available on the market, while 21% did not and the status of the remaining 7% was unclear.

Country	No	Unclear	Yes	Grand Total
AT			6	6
BE	1		1	2
BG	1			1
DE	8		26	34
DK	2	3	3	8
EE		1		1
ES	3		7	10
FI	1		8	9
FR	4	2	22	28
EL	1			1
IE			1	1
IT	5	1	7	13
NL	2	1	12	15
PL	1	1	6	8
PT			1	1
SE			1	1
SI	1			1
Grand Total	**30**	**9**	**101**	**140**
	~21%	**~7%**	**~72%**	

***Table 11.11**. Market availability of quantum technology products by Member State*

Table 11.12 provides a further breakdown of product availability among EU quantum technology companies by technology segment.

Products	No	Unclear	Yes
Quantum sensing	28%	11%	61%
Quantum computing software	25%	7%	68%
Quantum computing hardware	26%	3%	71%
Quantum communication/key distribution	16%	4%	80%
Post-quantum cryptography	10%	5%	85%
Quantum control and metrology	0%	0%	100%

Quantum products for space	20%	0%	80%
Quantum chips	14%	14%	71%
Quantum random number generators	0%	40%	60%

Table 11.12. *Commercialisation status of EU quantum technology companies by technology area (%)*

Commercial readiness varies across technology domains, with the highest shares of firms marketing products in post-quantum cryptography (85%) and quantum key distribution (80%), compared with quantum sensing (61%) and quantum computing software and hardware (68% and 71%, respectively).

75.1. VENTURE CAPITAL INVESTMENT BY FINANCING STAGE

Tables 11.12 and 11.13 present annual venture capital (VC) investments in quantum technology companies by financing stage and location of the recipient company (EU27, United States and rest of the world). The figures are based on a JRC analysis using PitchBook data and are expressed in EUR million. While the annual data extend back to 2015, the aggregate comparisons cover the period 2020–2025.

75.1.1. Early-stage VC

Table 11.13 presents annual early-stage VC investments in quantum technology companies by geographical location.

Early-stage VC	**Location of target Q company**		
	EU27	**US**	**Rest**
2015		0.7	71.9
2016		35.2	11.5
2017		165.0	5.6
2018	0.0	35.7	27.4
2019	16.8	36.4	74.6
2020	7.9	61.6	77.9
2021	81.8	85.0	295.3
2022	96.2	99.7	274.0
2023	219.2	10.8	117.9
2024	86.7	20.0	48.4
2025	17.5	24.7	5.3
total 2020-25	**509.3**	**301.8**	**818.8**

Table 11.13. Early-stage VC investments by location (EUR million)

75.1.2. Late-stage VC

Table 11.14 presents the corresponding figures for late-stage VC investments.

Late-stage VC	**Location of target Q company**		
	EU27	**US**	**Rest**
2015			
2016			
2017			
2018			0.0

2019			35.4
2020		410.5	63.3
2021		430.0	128.1
2022	160.2	585.5	322.7
2023	84.7	24.9	334.1
2024	104.4	648.7	322.0
2025	144.2	124.6	49.7
total 2020-25	**493.4**	**2,224.0**	**1,219.8**

Table 11.14. Late-stage VC investments by location (EUR million)

75.2. LARGE FUNDING ROUNDS AND INVESTOR ORIGIN

This subsection presents findings from the supporting PPMI/d-fine study on large funding rounds in quantum technology companies. The analysis covers 188 funding rounds, classified by funding round size and geographical origin of investors.

Table 11.15 presents the distribution of the identified funding rounds by investor origin across all quantum technology companies included in the study.

Funding Round Size	Only EU Investors	Mixed Investors	Only Non-EU Investors	Investor Origin unknown	Total	%
Large (>25M EUR)	13	7	58	17	**95**	**100**
Very Large (>50M EUR)	8	3	36	12	**59**	**100**
Extremely Large (>100M EUR)	3	3	18	10	**34**	**100**
Total					**188**	

Table 11.15. Large funding rounds by investor origin considering all quantum companies

Table 11.16 provides the corresponding breakdown for EU-based quantum technology companies.

Funding Round Size	Only EU Investors	Mixed Investors	Only Non-EU Investors	Investor Origin unknown	Total	%
Large (>25M EUR)	12	1	3	2	**18**	**18.9%**
Very Large (>50M EUR)	7	1	2	1	**11**	**18.6%**
Extremely Large (>100M EUR)	3	1	1	1	**6**	**17.6%**
Total					**35**	

Table 11.16. Large funding rounds by investor origin considering EU-based quantum companies

75.3. DEMAND-SIDE SUPPORT AND PUBLIC PROCUREMENT

This subsection presents findings from the supporting PPMI/d-fine study on public procurement initiatives supporting quantum technologies in the EU. The mapping covers quantum computing systems, quantum communication infrastructure deployments and a quantum key distribution microsatellite pilot mission.

Table 11.17 provides an overview of the identified procurement schemes, including the types and numbers of quantum systems procured, their geographical scope and the buyers involved.

Procurement scheme	Country /level	Quantum systems procured	Number of distinct buyers	Buyers identified	Ref.
EuroHPC JU quantum computer acquisition	EU	8	8	IT4Innovations, PSNC, FZ Jülich, CEA/GENCI, LRZ, CINECA, BSC, LuxProvide, SURF.	[1]
HPCQS PPI	EU + MS	2	2	CEA/GENCI, FZ Jülich	[2]
DLR Quantum Computing Initiative (DLR QCI)	DE (MS)	11	1	DLR	[3]
VTT FiQCI original procurement (5→50 qubit)	FI (MS)	1	1	VTT	[4]
VTT FiQCI new procurement (150→300 qubit)	FI (MS)	2	1	VTT	[5]
EuroQCI national deployment projects (incl. CEF Digital cross-border)	EU + 27 MS	27 national + 19 cross-border + 6 industry	27 MS + 6 industry	Minimum 27 national implementing bodies (NRENs, telecom regulators, research institutes). Actual count higher: some projects have multiple partners.	[6]
BMBF Quantum Systems	DE (MS)	2	1	LRZ	[7]
QuNorth / Magne (Denmark quantum computer acquisition)	DK (MS)	1	2	EIFO (quasi-public) + Novo Nordisk Foundation (private).+M15+M13	[8]
PROQCIMA (French defence quantum computer programme)	FR (MS)	5	1	DGA/French Ministry of Armed Forces	[9]
Quantum Spain (national quantum computer procurement)	ES (MS)	1	1	BSC (Barcelona Supercomputing Center) as host/operator.	[10]
IRIS² QKD microsatellite pilot mission	EU	1	1	DG CNECT	[11]

Table 11.17. Public procurement schemes supporting quantum technologies in the EU

The mapping identifies the procurement of 32 quantum computer prototypes, 52 quantum communication infrastructure deployments and one microsatellite system. It also identifies 12 distinct buyers of quantum computer prototypes, 33 buyers of quantum communication infrastructures, and one buyer of the microsatellite system.

[1] EuroHPC JU, Consolidated Annual Activity Report 2022, p. 25 (quantum computer acquisition budgets of €8–10 million and 50% EuroHPC JU co-funding; see also EuroHPC JU Governing Board Decision No. 27/2022); EuroHPC JU, *Consolidated Annual Activity Report 2023*, annex to Governing Board Decision No. 27/2024, p. 65 (quantum infrastructure activities, hosting agreements, calls for expressions of interest and consortium arrangements); EuroHPC JU, *Consolidated Annual Activity Report 2024*, annex to Governing Board Decision No. 24/2025, p. 6 (four procurement contracts totalling €50,653,000, including an EU contribution of €22,826,500), pp. 43–44 (procurement activities) and pp. 54–58 (quantum computer specifications). Reports available via the EuroHPC JU official document repository.
[2] HPCQS Consortium, New EU Research Project HPCQS, project announcement

[3] German Aerospace Center (DLR), Quantum Computers, DLR Quantum Computing Initiative; German Federal Ministry for Economic Affairs and Climate Action, Quantum Computing in Germany, press release (2022); DLR, Quantum Computers: Out of the Lab, into the World, news article (2023).
[4] Finnish Ministry of Economic Affairs and Employment, Building of Finland's First Quantum Computer Begins: VTT Partners with Quantum Startup IQM, press release; Finnish Public Procurement Competence Centre, Procurement of a Quantum Computer: Case VTT, case study; VTT Technical Research Centre of Finland, VTT and IQM Launch First 50-Qubit Quantum Computer Developed in Europe, news release.
[5] Finnish Ministry of Economic Affairs and Employment, Building of Finland's First Quantum Computer Begins: VTT Partners with Quantum Startup IQM, press release; Finnish Public Procurement Competence Centre, Procurement of a Quantum Computer: Case VTT, case study; VTT Technical Research Centre of Finland, VTT and IQM Launch First 50-Qubit Quantum Computer Developed in Europe, news release.
[6] VTT Technical Research Centre of Finland, IQM Quantum Computers to Supply Finland with a World-Leading Superconducting 300-Qubit Quantum Computer, news release.
[7] European Health and Digital Executive Agency (HaDEA), European Quantum Communication Infrastructure (EuroQCI), European Commission, programme overview.
[8] German Federal Ministry of Research, Technology and Space, Q-Exa: Quantencomputer-Erweiterung durch Exa-Scale-HPC, project profile (2021–2024); German Federal Ministry of Research, Technology and Space, MAQCS: Multikern Atomare Quantencomputing Systeme, project profile (2023–2027); Quantum Computing Report, Denmark's QuNorth to Acquire 50 Logical Qubit Magne Quantum Computer from Atom Computing and Microsoft, industry news article.
[9] Alice & Bob, French Government Taps Alice & Bob to Deliver Scalable Fault-Tolerant Systems with €500M in Funding, press release (2024); The Quantum Insider, French Defense Agency to Award Startups €500 Million Plus to Build Universal Quantum Computers, 9 March 2024.
[10] European Commission, Quantum Spain: Spanish Supercomputing Network, Recovery and Resilience Facility project overview; Qilimanjaro Quantum Tech, Successful First Delivery for the Quantum Spain Project to Build the First Spanish Quantum Computer, company announcement; Barcelona Supercomputing Center (BSC-CNS), BSC Quantum Spain Computer, project information.
[11] European Commission, Directorate-General for Communications Networks, Content and Technology (DG CNECT), IRIS² QKD Microsatellite Pilot Mission — Tender Specifications, procurement reference EC-CNECT/2025/OP/0129 (2025).

76. ACCESS TO QUANTUM TECHNOLOGY INFRASTRUCTURES

The tables below present aggregated findings from the supporting PPMI/d-fine study, which mapped quantum technology infrastructures across the EU, including quantum computing, communication and sensing testbeds, as well as pilot lines.

The findings indicate that only 18 of the 91 mapped testbeds were identified as offering some form of access or potential access to start-ups, while 8 of the 27 mapped pilot lines had identified access arrangements (Table 11.18). A substantial proportion of the mapped infrastructures are either still planned or subject to restricted, project-based or unclear access conditions.

Infrastructure category	Total mapped	Accessible or potentially accessible	Restricted, unclear or unspecified	Planned
Quantum computing testbeds	49	12	11	26
Quantum communication testbeds	36	4	31	1
Quantum sensing testbeds	6	2	3	1
Total testbeds	**91**	**18**	**45**	**28**
Pilot lines	**27**	**8**	**10**	**9**
Total	**118**	**26**	**55**	**37**

Table 11.18. Accessibility of mapped quantum technology testbeds and pilot lines in the EU

As shown in Table 11.19, access modalities vary across infrastructure types, including paid access, calls for applications, conditional access and national access arrangements. Access to quantum computing testbeds is predominantly fee-based, whereas access to pilot lines is mainly organised through calls for applications or national arrangements. These differences illustrate that the availability of infrastructure does not necessarily translate into unrestricted access for start-ups.

Access modality	Quantum computing	Quantum communication	Quantum sensing	Pilot lines
Total infrastructures mapped	**49**	**36**	**6**	**27**
Paid access	10	0	0	1
Call-based access	1	1	1	4
Conditional access	1	0	0	0
Open access	0	1	0	0
National access arrangements	0	0	0	3
Potential access through direct contact	0	2	1	1
Restricted, project-based or unclear access	9	31	3	9
Access not specified	2	0	0	0
Planned	26	1	1	9

Table 11.19. Access modalities for mapped quantum technology testbeds and pilot lines in the EU

77. SUPPLY CHAIN DEPENDENCIES AND VULNERABILITIES

This section presents findings from the supporting PPMI/d-fine study on EU supplier availability, dependencies on non-EU sources and project extensions associated with supply constraints in quantum technologies.

77.0. EU SUPPLIER AVAILABILITY FOR COMPONENTS AND SUBCOMPONENTS

The supporting PPMI/d-fine study assessed the availability of EU suppliers for 47 quantum technology components and subcomponents. Table 11.20 presents the distribution of these items according to whether no EU supplier, a single EU supplier or multiple EU suppliers were identified.

Category	No EU source	Single EU source	Multiple EU sources	Total components evaluated
Main components	3	1	27	**31**
Subcomponents	6	2	8	**16**
Total	**9**	**3**	**35**	**47**

Table 11.20. Availability of EU suppliers for quantum technology components and subcomponents

77.1. DEPENDENCIES ON NON-EU SOURCES BY TECHNOLOGY USE CASE

Table 11.21 presents the findings of the supporting study on dependencies on non-EU sources across nine quantum technology use cases, distinguishing between dependencies identified for main components alone and those identified when subcomponents are also considered.

Use case	Depends on non-EU excluding sub-components	Depends on non-EU including sub-components
Quantum Computing/Simulation – Neutral atoms	TRUE	TRUE
Quantum Computing/Simulation – Ions	TRUE	TRUE
Quantum Computing/Simulation – Superconducting Qubits	TRUE	TRUE
Quantum Computing/Simulation – Photons	FALSE	TRUE
Quantum Computing/Simulation – Vacancy centres	FALSE	TRUE
Quantum Communication	FALSE	TRUE
Quantum Sensing – Ions	TRUE	TRUE
Quantum Sensing – Neutral atoms	TRUE	TRUE
Quantum Sensing – Vacancy centres	FALSE	TRUE
Use cases with non-EU dependencies	**5 of 9**	**9 of 9**

Table 11.21. Dependency on non-EU sources by quantum technology use case

77.2. PROJECT EXTENSIONS ASSOCIATED WITH SUPPLY CONSTRAINTS

The supporting study examined an illustrative sample of 23 quantum communication projects to assess project extensions and their reported causes. Table 11.22 presents the number and proportion of projects affected, distinguishing between predominantly

component- or supply-related constraints and administrative or regulatory factors, together with the average extension duration.

Project status / reported cause	Number of projects	Share of total projects	Share of extended projects	Average extension (days)
Projects with extensions	**11**	48%	100%	
Of which: predominantly component or supply-related constraints	**8**	**35%**	**73%**	**191**
Of which: predominantly administrative or regulatory factors	3	13%	27%	303
Projects completed on time	12	52%		**0**
Total projects examined	**23**	**100%**		

Table 11.22. Project-level analysis of 23 quantum communication projects; percentages are rounded

In total 11 (48%) experienced extensions. Predominantly component- or supply-chain-related constraints affected 8 of these projects (73%), with an average delay of approximately 191 days, while the remaining 3 (27%) reported administrative or regulatory factors, averaging 303 days.