Use Case Submission Guidelines

July 2025

OQI
Open Quantum
Institute

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1. Introduction

As part of the Open Quantum Institute's general mission to promote global, equitable and inclusive access to quantum computing, OQI is working towards **rebalancing the focus of quantum computing applications towards creating impact for the benefit of humanity** while counteracting the hype effects. To advance this goal, OQI is building a curated repository of SDG use cases [1], designed to inspire the global community of researchers and developers.

These guidelines were designed to support the global community with a methodology for developing strong quantum computing use cases that address global challenges, such as those defined by the United Nations (UN) Sustainable Development Goals (SDGs) and its succeeding framework. The use case development phases progress from ideation to scoping and developing a proof of concept. If resources permit, some of the use cases may receive free credits for early testing and implementation on quantum simulators and quantum processors available on OQI's partners' cloud platforms.

OQI is fostering the growth of a global community of practice dedicated to rigorously exploring the potential quantum solutions to address real world problems. In this context, OQI focuses on **demonstrating the applicability of existing quantum methods**, rather than discovering new ones. While some ideas generated through OQI collaborations may highlight the need for new quantum methods, the research and development of these methods falls outside the scope of OQI's focus and support.

To facilitate use case exploration, OQI provides a platform for collaboration and mentorship for multidisciplinary use case teams composed of quantum experts, domain experts and SDG experts from UN or large NGOs to develop use cases.

In the following sections, detailed information is provided to guide through the use case development:

- What is quantum Computing and what are the SDGs
- What are the phases of development of use case supported by OQI
- What are the roles and responsibilities

2. Focus of OQI: Quantum Computing Applications for SDGs

2.1 What is Quantum Computing?

Quantum computers exploit quantum mechanics—the laws of physics that govern the behaviour of matter at the very small scale. Quantum computers are not general-purpose, and for many tasks they provide no advantage over current computational technology. But, for certain problems they can, in theory, provide unprecedented computational benefits (e.g. speed-ups, accuracy) over classical computers [2]. These capabilities could impact key economic sectors, including pharmaceuticals, materials science, chemistry, energy, finance, security, and logistics. Quantum computers could also help address a range of challenges central to the SDGs.

The most relevant approaches for quantum computing applications towards the SDGs can be grouped under the following categories:

a) **Quantum simulation** [3]: to model quantum systems at the nanoscale and below, where quantum effects are significant and relevant to physical, chemical and biological processes. Quantum computers are a natural fit for simulating quantum phenomena, and could offer greater accuracy for modelling large quantum systems and exponential speedup over what is intractable on classical computers.

b) **Machine learning** [4]: to improve the predictive ability of statistical models and to analyse and draw inferences from data patterns. This approach is particularly promising for applications involving small datasets, which are challenging to learn using current machine learning approaches.

c) **Optimisation** [5]: to approximate the optimal solution to a problem (i.e. maximising or minimising an objective function) with a large number of options and constraints, including through heuristic approaches.

d) **Linear system of equations and partial differential equations (PDEs)** [6]: to simulate complex, high-dimensional processes and dynamics through solving linear systems of equations and PDEs.

Other quantum approaches, with limited relevance to SDGs, also exist. For instance, factorisation is the process of breaking numbers down into smaller ones and serves as the basis of modern encryption schemes [7]. While important in the realm of cybersecurity, its direct relevance to the SDGs is more limited.

It is important to emphasize that the categorization of quantum approaches above is independent of the performance of the related (quantum or quantum-inspired) algorithms. In this sense, a specific quantum approach does not necessarily imply that the (quantum or quantum-inspired) algorithm, if implemented, would outperform classical benchmarks. We make a distinction between quantum and quantum-inspired algorithms:

- **Quantum-inspired algorithms** are classical in nature, but are inspired by quantum physics / quantum algorithms [8], [9]. Such algorithms are designed to run on classical computers and offer performance improvements. However they are not a substitute for quantum computing solutions.

- **Quantum algorithms** are harnessing quantum mechanics principles and designed to run on quantum computers, offering potentially an advantage for specific problems. An exhaustive list is available on the Quantum Algorithms Zoo [10].

2.2 What are the Sustainable Development Goals (SDGs)?

In 2015, the United Nations Member States adopted the 2030 Agenda for Sustainable Development, which provides a shared blueprint for achieving peace and prosperity for both people and the planet, now and in the future. There are 17 Sustainable Development Goals (SDGs) [11] each with clear targets and actions addressing the global challenges, including those related to poverty, inequality, climate change, environmental degradation, peace and justice. All 17 SDGs are interconnected, recognising that development must balance social, economic and environmental sustainability. The UN is working on a succeeding framework [12] for global partnerships beyond the 2030 Agenda.

A core mission of OQI is to harness quantum computing to address the SDGs. OQI's science diplomacy community supports and emphasises the importance of anticipating the readiness of quantum computers and identifying future SDG-relevant use cases for quantum researchers and developers to start exploring now.

While quantum computers are still under development and reliable, scalable devices aim to be operational in the next 5 to 25 years, SDG-relevant use case solutions can already begin to take shape using currently available quantum simulators. This approach will guide the R&D community to focus on areas with the greatest potential to contribute to the UN 2030 Agenda for Sustainable Development and its succeeding framework.

2.3 Examples of OQI use cases under development

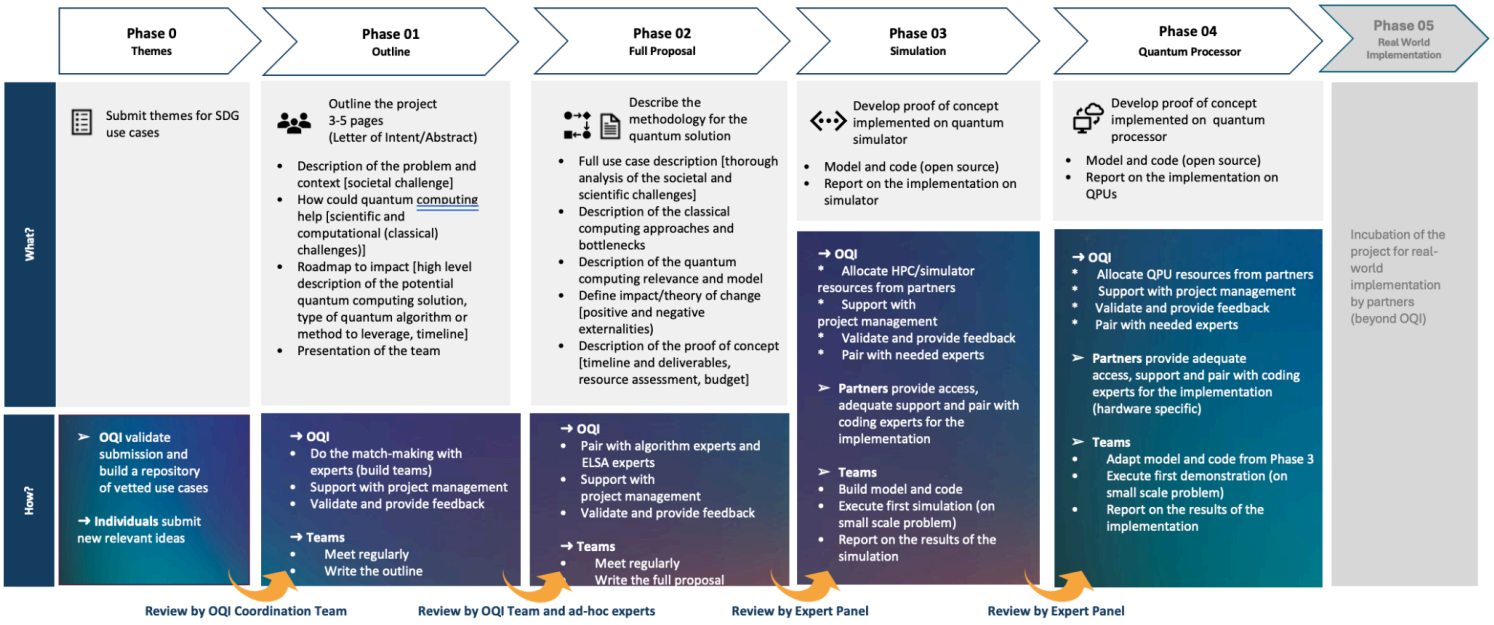
Examples of use case outlines can be found on the OQI website [1] and in the OQI SDG Use Case White Paper 2024 [13] White Paper 2023 [14] and White Paper 2022 [15].
New proposals should not be limited to the topics and examples illustrated on the OQI website.

3. Process for developing a use case with OQI

The development of use cases with OQI is a multiphase process, as outlined below. Due to the current low maturity of quantum computers and the varying complexity of potential use cases, only a selection of proposed use cases are likely to progress to advanced stages, such as simulation on classical and implementation on quantum devices.

As a governance initiative rather than a research institute, OQI focuses its efforts on identifying and supporting quantum computing use cases that align with Sustainable Development Goals (SDGs).

3.1 Use case development phases



3.1.1 Building a repository

The first two phases will contribute to building a large repository of vetted use cases.

Phase 0: Identification of an idea for a use case.
This is the starting point for identifying relevant SDG challenges that can be addressed by quantum computing. OQI is building a large repository of use case ideas to further inspire and encourage more participation in the journey. This repository is populated through direct contributions (e.g. call for submissions, workshops, etc.) and through the curation of external use cases initiatives (e.g. OQI partners and like-minded organisations). Submission of use case ideas can be done through the online form.

Phase 1: Preparation of an outline, following the OQI outline template (Annex 1).
The outline describes the context surrounding the identified SDG-relevant problem, including the societal and scientific challenges that can be addressed with

computational solutions. It outlines how quantum computing could potentially help and the expected impact of such an innovative solution. The outline is reviewed by the OQI Coordination Team, and, as needed, may be consulted with an expert panel spanning diverse areas of expertise (quantum, domain specific, impact and SDGs).

3.1.2 Proof of Concept

A few use cases will be selected for OQI support (technical and financial) to move to advanced phases and develop a **proof of concept (POC**). In the context of OQI, a **POC** is a demonstration that quantum computing can solve a problem, either on current quantum hardware devices, within the Noisy Intermediate-Scale Quantum (NISQ) era, or in terms of future Fault-Tolerant Quantum Computing (FTQC) hardware. This problem must also be representative of a real-world SDG problem and its quantum solution must aim to provide some sort of advantage over its classical counterparts, at least when being deployed on FTQC.

Going through the process of the POC, the use case team will rigorously assess the complexity and computational challenges and analyze the potential (feasibility) of a quantum computing solution, with the identification of the quantum approach (quantum or quantum-inspired), the resources needed, the benchmarking strategy against state-of-the-art classical approach, the timeline for an implementation on quantum devices, which could lead - resources permitting - to testing on quantum devices.

Phase 2: Preparation of a full proposal, using the OQI full proposal template (Annex 2). The full proposal should detail the POC, with its methodology-including planning, developing the computational model with a justification of the quantum approach and a strategy for benchmarking with classical computers, a rigorous quantum computing resource assessment, and an impact assessment of the potential quantum solution. The full proposal will be reviewed by an expert panel with diverse expertise (quantum, domain specific, impact, SDGs). Following the completion of the full proposal, the OQI scientific committee will review it and provide feedback on the value and feasibility to move to the next phase.

Phase 3: If a small-scale POC is implementable on today's quantum simulators accessible on the cloud, this phase is designed to test the potential quantum computing solutions. OQI will offer cloud access to selected projects to implement their POC, through close collaboration with OQI's quantum computing provider partners. The results of the simulations will be reviewed by the OQI scientific committee to provide feedback on the value and feasibility to move to the next phase.

Phase 4: If Phase 3 is satisfactory, implementation on quantum processors accessible on the cloud will then be considered, subject to availability of quantum processors. From the results of the implementation, an assessment of how the use case would perform on large scale fault-tolerant quantum computers will be done. This phase will also be carried out in close collaboration with OQI's quantum computing provider partners.

Phase 5: Testing and deployment in the real world—this phase goes beyond the responsibility of OQI, although OQI may help in finding a sponsor.

3.2 Evaluation process

The evaluation of use cases to move to an advanced phase is based on three main criteria:

1. Relevance, feasibility and readiness of the proposed quantum solution
2. Level of global impact

3. Quality of the team

General evaluation criteria

Scientific relevance	a. Is the proposal scientifically sound? b. Are there clear goals and a methodology to achieve the project?
Quantum computing relevance	a. Is there a clear mathematical description of the problem? b. Is there a clear assessment of the computational approach to numerically solve the mathematical problem and are the classical bottlenecks well identified? c. Is there a clear relevance and need for quantum computing (i.e. does the level of complexity of the problem require quantum computing)? d. Are the needs for computing resources (quantum and HPC simulation) well estimated? e. Is the quantum computing approach reusable for other problems? *f. In phases 3 & 4 - Is the code adapted to an implementation on a quantum simulator and/or quantum processor?*
Impact relevance	a. Does the quantum solution answer a "business" need (i.e. a challenge validated by an IGO)? b. Is there a clear assessment of the interlinkages between SDGs (benefits and risks of negatively impacting other SDGs)? c. Is there a clear assessment of how to measure impact short/mid/long term, both at the local and global scale? d. Is there access to a relevant dataset representative of the real-world problem?
Use case team composition	a. Is the use case team diverse and inclusive in terms of expertise, geography and demography (priority on quantum-underserved geographies)? b. Does the use case team have the necessary expertise and means to achieve the project? c. Is the use case team able to collaborate with openness between multi stakeholders (e.g. IP considerations, private data)?

OQI provides support, with constructive feedback and access to a network of experts, throughout the use case development process to maximize the progress of the projects and ensure high quality use cases. The table below summarizes the selection process.

	Deliverable	Selection Committee	Additional Step
Phase 0 to Phase 1	Detailed use case idea	OQI coordination team, with the support of the CERN-QTI	
Phase 1 to Phase 2	Outline (see template in Annex 1)	OQI coordination team, with ad hoc consultation with multidisciplinary experts of in depth knowledge on quantum computing applications and/or in SDGs and its succeeding framework	For use cases deemed to be eligible for Phase 2, the use case team will be invited to prepare an action plan (see template in Annex 3), including an assessment of the budget and resource required to complete a full use case proposal (deliverable of Phase 2). Once this plan is approved, the use case team will proceed to Phase 2.
Phase 2 to Phase 3	Full proposal (see template Annex 2)	OQI coordination team, with a panel of multidisciplinary expert panel of in depth knowledge on quantum computing applications and/or in SDGs and its succeeding framework and quantum computing provider. Recommendations and constructive feedback will be shared with the teams – without possibility of complaint and dispute.	For use cases deemed to be eligible for Phase 3, the use case team will refine its action plan (see template in Annex 3), including an assessment of the budget and resource required to complete an implementation on simulator (deliverable of Phase 3). Once the plan is approved, the use case team will proceed to Phase 3. The use case team will then work closely with the selected quantum provider to plan an effective implementation.
Phase 3 to Phase 4	Code and report on the simulation results	OQI coordination team, with a panel of multidisciplinary expert panel of in depth knowledge on quantum computing applications and/or in SDGs and its succeeding framework and quantum computing provider. Recommendations and constructive feedback will be shared with the teams – without possibility of complaint and dispute.	If simulation results are satisfactory and could lead to realistic implementation of the code on a quantum processor, the use case team will refine its action plan (see template in Annex 3), including an assessment of the budget and resources required to complete an implementation on a quantum processor (deliverable of Phase 4). Once the plan is approved, the use case team will proceed to Phase 4. The use case team will then work closely with the selected quantum provider to plan an effective implementation.

4. Roles and Responsibilities

OQI serves as a neutral platform to support use case teams of multidisciplinary backgrounds to work on use cases. In particular, OQI is encouraging the participation of researchers and developers from regions in the world that do not have access to quantum resources, whether in terms of access to the technology and/or training (defined below as "quantum-underserved geographies").

4.1 Key stakeholders and what's in it for them

UN Organisations & large NGOs	• Participate in the acceleration of achieving the SDGs and succeeding framework • Inject innovation for future solutions of existing/projected real-world issues • Think out of the box through exposure to quantum and domain expert networks • Foster interdisciplinary collaboration
Domain experts	• Exposure to quantum and UN networks • Apply their expertise on solutions to validated real-world issues • Access new funding streams • Access new datasets
Quantum experts	• Access UN and domain expert networks • Apply their quantum expertise on solutions to validated real-world issues • Access free quantum computing resources for proof of concepts • Access new funding streams • Publish high impact publications with OQI affiliation
Quantum industry	• Access talent (new hires) • Showcase their technology capability, with validated real-world issues and benchmark against other providers • Participate in global sustainability effort • Access UN and domain expert networks
Countries	• Build local capacity - related to OQI's educational pillar (A3) • Bring quantum computing applications to local areas

4.2 Use case participants

Participants in each use case will form multidisciplinary teams of researchers and developers. Each use case team is composed of:

- Domain experts
- Quantum computing experts
- SDG-focused organisations (e.g. UN and international organisations or large IGOs/NGOs)

Roles and responsibilities:

- Suggest the topic for a use case.
- Work in a team to develop a use case.
- Commit to participate in the activities and use the resources made available by OQI and take all measures that can reasonably be expected of the participants to bring this collaboration to a successful outcome.
- Contribute to the OQI use case repository.
- Leverage OQI (and other) tools and resources available for learning and training to be equipped to fully develop a use case.
- Communicate needs to OQI for support with complementary expertise or seed funding.
- Perform the necessary work to develop a proof of concept (see use case development phases below).
- Each participant will become an official OQI member through their affiliation, abiding to OQI values, after completing the bilateral OQI Framework Agreement—which defines the confidential information and intellectual property consideration.
- Each participant will be required to complete the multilateral OQI Use Case Project Agreement—which defines the use case statement of work and the role of each participant in the use case team.
- Each participant is responsible for bringing their own funding for their time invested in the development of use cases. Requests with detailed justification can be made for additional financial support from OQI. OQI has a limited budget for seed funding, prioritising team participants with fewer resources and access.

4.3 OQI coordination team

OQI coordinates and supports the participants in their use case development.

Roles and responsibilities:

- Accompany participants in developing the use case, with project management support, ad hoc technical support and training.
- Offer matchmaking to form teams of participants with complementary expertise.
- In some cases, provide seed funding for the development of use cases (based on specific criteria and availability).
- Activate cloud access to quantum simulators and quantum processors from OQI partners for projects that reach the phase of implementation of their proof of concept.
- Provide participants with access to the OQI use case repository.
- Provide participants with access to OQI repository of tools and resources for learning and training.
- Organise events (e.g. workshops) and provide a platform for exchange of best practices.

4.3 Confidentiality and intellectual property

In the spirit of contributing to the OQI repository of use cases, selected ideas and outlines will be openly shared with the OQI community and published on the OQI website.

For later stages of the use case development (phase 2 and beyond), all details provided in the submissions to OQI will remain confidential. However, in the spirit of open science, use case teams will be required to share their proposals and results publicly in some format (e.g. arXiv, GitHub, etc.) to help advance the field.

Participants will retain ownership of the intellectual property (IP) they contribute to the use case projects, as well as any developed during the project. OQI serves as a neutral platform to facilitate use case development and does not retain any IP. For use case teams moving to Phase 2, a project agreement will be signed by all use team participants to define the intellectual property agreement.

Personal data that is provided will be processed in accordance with OQI privacy policy [16]. If necessary, a standard mutual non-disclosure agreement (NDA) can be requested.

By confirming their participation in the OQI programme, the selected teams agree to actively participate in the activities provided by the OQI, as well as allocate the necessary resources to successfully complete the deliverables in each phase.

OQI reserves the right to exclude a project that does not comply with these guidelines or whose behaviour could harm the reputation of the programme, OQI teams, its stakeholders or other participants. This includes, but is not limited to, lack of team engagement, failure to complete tasks or deliverables, disrespectful behaviour towards OQI, its team members and stakeholders or other participants, violation of confidentiality agreements or unethical business practices

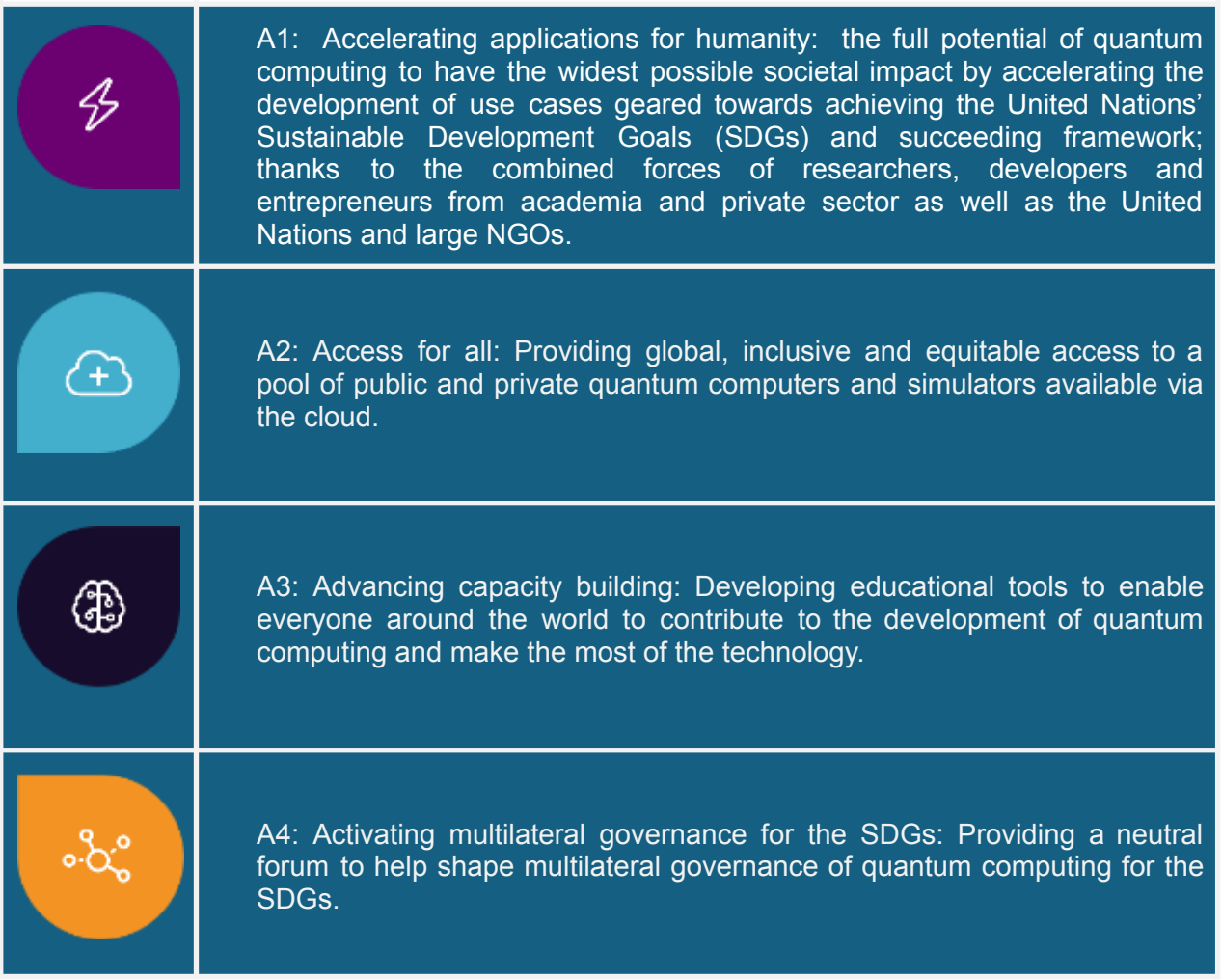
OQI reserves the right to modify, at any time, the content, duration and services of the programme, including, but not limited to the support provided, the guidance, materials and resource, as well as the seed funding.

OQI cannot be responsible for any loss perceived or incurred, damage, liability, cost or expense of any kind that may arise from or in connection with the teams' participation in the programme, any advice, guidance or recommendation provided by OQI or actions or omission from OQI, its teams and stakeholders or other participants.

5. About OQI

OQI is a multilateral governance initiative that promotes global and inclusive access to quantum computing and the development of applications for the benefit of humanity. As a novel science diplomacy instrument, it brings together research, diplomacy, the private sector and philanthropy stakeholders.

OQI's mission is divided into four pillars



Objective of the OQI – Pillar A1

As part of the A1 pillar, OQI aims at becoming a centre for expertise in the application of quantum computing for the SDGs (and their future succeeding framework). OQI supports the development of use cases, which are rigorously vetted based on their scientific and impact merits. Given the current limited resources and experts in the field, OQI hopes to contribute to rebalancing the focus of quantum computing applications towards impact while counteracting the hype effects.

FAQs

Use Case Team

I would like to submit an idea, but I don't have a full use case team—how should I proceed?

It is part of OQI's role to do the matchmaking. For relevant ideas, OQI will support the completion of use case teams, bringing UN organisations, domain experts and quantum experts together to form a team.

XPRIZE

How is OQI's Call for Submissions different from the XPRIZE Quantum Applications competition [17]?

- XPRIZE launched a 3-year, $5M competition with a more ambitious scope to demonstrate quantum advantage for real-world applications. This includes showing applicability to new real-world applications, reducing quantum computing resources and discovering new quantum algorithms for solving a new class of problems; all demonstrating quantum advantage.
- OQI is specifically focusing on demonstrating the applicability of existing quantum methods to SDG-relevant areas.
- The two initiatives are in synergy. GESDA, the initiator of OQI, is the presenting partner for the XPRIZE Quantum Applications competition. Projects selected by XPRIZE will be featured in the OQI repository of vetted use cases. In addition, OQI use cases with the potential of contributing to innovative projects may be submitted to XPRIZE (depending on the eligibility).

Funding

Is there funding for the development of use cases?

- For the ideation and scoping of use case outlines (phases 0 and 1), there is no financial support. For the proof of concept (phases 2, 3 and 4), OQI can provide seed funding for only a limited number of projects, prioritising quantum-underserved geographies and high impact projects. If your project and use case team do not fall into the selection for support, OQI may be able to direct you to other funding mechanisms that can support advanced use case development phases (e.g. regional government funding, etc.)

Scope of topics

Which topics do not fall into OQI scope?

- Topics falling outside of OQI's scope include, but are not limited to, encryption, post-quantum cryptography, national security and defence applications.
- OQI is aware of the potential risks and threats of quantum computing for national security and the geopolitical implications. This is considered in OQI's diplomatic pillar (A4).
- However, for use case development,OQI's focus is on where global cooperation can bring positive impact to humanity, leveraging the UN framework on the SDGs and succeeding framework.

Access

How and when will I have access to quantum simulators and quantum processors (as part of an OQI use case team)?

- For selected projects, OQI will provide access to its partners cloud platform, providing use case teams with free credits for implementation on quantum simulators and quantum processors. Use case teams from selected projects will work closely with the quantum providers (OQI partners) to prepare implementations and optimise the utilisation of the quantum resources. OQI cannot support all projects for implementations to advanced phases (see selection criteria).

Intellectual property

If I develop a new quantum method, who will own the intellectual property?

- Participants will retain ownership of the intellectual property (IP) they bring to the use case projects, and which they develop as part of their use case. For teams moving to Phase 2, a project agreement will be signed by all participants to define the IP agreement. OQI is a neutral platform to facilitate use case development and does not retain any IP.

Bibliography

[1] Open Quantum Institute [Online]. Available: https://open-quantum-institute.cern/applications/.

[2] F. Arute, et al., "Quantum supremacy using a programmable superconducting processor," *Nature,* vol. 574, p. 505, 2019. [Online]. Available: https://www.nature.com/articles/s41586-019-1666-5

[3] M. Reiher, et al., "Elucidating reaction mechanisms on quantum computers," *PNAS,* vol. 114, pp. 7555-7560, 2016. [Online]. Available: https://www.pnas.org/doi/10.1073/pnas.1619152114

[4] J. Biamonte, et al., "Quantum Machine Learning," Nature, vol. 549, p. 195–202 , 201. [Online]. Available: https://www.nature.com/articles/nature23474

[5] A. Farhi, J. Goldstone, "Quantum Approximate Optimization Algorithm," *arXiv,* vol. 1411.4028, 2014. [Online]. Available: https://arxiv.org/abs/1411.4028

[6] A. W. Harrow, A. Hassidim S. Lloyd, "Quantum Algorithm for Linear Systems of Equations," *Phys. Rev. Lett. ,* vol. 103, p. 150502, 2009. [Online]. Available: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.103.150502

[7] P. W. Shor, "Algorithms for quantum computation: discrete logarithms and factoring," Proceedings 35th Annual Symposium on Foundations of Computer Science, Santa Fe, NM, USA, pp. 124-134, 1994.[Online]. Available: https://ieeexplore.ieee.org/document/365700

[8] A. Gilyén, S. Lloyd, E. Tang, “Quantum-inspired low-rank stochastic regression with logarithmic dependence on the dimension,” *arXiv*, vol. 1811.04909, 2018. [Online]. Available: https://arxiv.org/abs/1811.04909

[9] N.H. Chia, H.H. Lin, C. Wang, “Quantum-inspired sublinear classical algorithms for solving low-rank linear systems,” *arXiv*, vol. 1811.04852, 2018.[Online]. Available: https://arxiv.org/abs/1811.04852

[10] Quantum Algorithm Zoo [Online]. Available: https://quantumalgorithmzoo.org/

[11] United Nations Sustainable Development Goals [Online]. Available: https://sdgs.un.org/goals.

[12] United Nations Summit of the Future [Online]. Available: https://www.un.org/en/summit-of-the-future.

[13] OQI Use Case White Paper 2024 [Online]. Available: https://open-quantum-institute.cern/wp-content/uploads/2024/OQI_WhitePaper2024_v151024.pdf.

[14] OQI Use Case White Paper 2023 [Online]. Available: https://open-quantum-institute.web.cern.ch/wp-content/uploads/2023/10/GESDA_OQI_WP1-WhitePaper2023_final_versionPDF.pdf.

[15] OQI Use Case White Paper 2022 [Online]. Available: https://open-quantum-institute.web.cern.ch/wp-content/uploads/2023/10/GESDA_OQI_Use-Cases_WhitePaper2022.pdf.

[16] CERN-OQI Privacy Policy [Online]. Available: https://oqi-dev-3.web.cern.ch/cern-privacy-policy/

[17] XPRIZE Quantum Applications Competition [Online]. Available: https://www.xprize.org/prizes/qc-apps

Point of Contact

Please reach out to oqi.usecase@cern.ch for any questions.

Annex 1 - Template Use Case Outline

Open Quantum Institute

Use Case Outline

Version: November 2024

1. Title

- List the relevant SDGs

2. Short Summary

(3-5 lines)

- *Description of the scope and key objectives of the project*

3. Description of the problem and context

(0.5-1 page plus references)

- *What is the societal challenge and why is it critical?*
- *Who and where is the affected population?*

4. Computational Challenge

(0.5-1 page plus *references*)

- *How is the societal challenge connected to a computational problem? What is the mathematical description of the problem?*
- *How is the challenge currently approached with existing technologies?*
- *How is this type of computational problem solved on classical computers and why are computational models useful?*
- *What type of computational methods are used?*
- *What is difficult to model and what are the current limitations/bottlenecks of the best in class classical computing approaches?*

5. Potential Impact of a Quantum Solution

(0.5-1 page plus references)

- *From the classical computing approach, which part could be tackled with quantum computing?*
- *What type of quantum algorithms and methods would be used and why?*
- *What are the projected expected benefits over classical approaches (speedup, accuracy etc.)?*
- *What would be the timeline for implementation (by classifying if a proof of concept could be done with NISQ[1] or FTQC[2] devices)?*
- *What quantum resources would be required to run a proof of concept (specify e.g. type of quantum hardware, number of qubits, depth of circuits, computation time needed (if possible), …)*

[1] NISQ refers to Noisy Intermediate-Scale Quantum devices available today.
[2] FTQC refers to Fault-Tolerant Quantum Computing devices, error corrected.

- *What datasets are available to this project? (please also specify other known / necessary initial conditions for the model)*
- *Describe how you envisage to complete a proof of concept for this project.*

6. References

7. Presentation of the use case team

Please present use case team participants and specify their relevant expertise for the project

Team Member (First name, Last name)	Affiliation	Country (of the affiliation)	Relevant domain expertise for the project (i) Quantum computing, ii) SDG domain, iii) Application domain, iv) Classical computation (e.g. AI, ML, chemistry, operation research, fluid dynamics, etc.), v) other)	Short Bio (3-5 sentences)

Please indicate any needed expertise to complete the use case team

Needed expertise to complete the above mentioned use case team	Names of potential experts to join the use case team	Profile links if available
Quantum computing		
SDG domain		
Application domain		
Classical computation (e.g. AI, ML, chemistry, operation research, fluid dynamics, etc.)		
Other (please specify)		

Annex 2 - Template Full Proposal

Instructions and background:

- *For each section the envisaged content is specified in italic. All of these comments should be removed before submitting the final document.*
- *Please be concise and respect the strict page limit of 15 pages for the main part of the full proposal (excluding the Methods section, the Team Presentation section and References).*
- *The purpose of the Full Proposal is to present a compelling story for your use case. Based on this a decision regarding the feasibility of a meaningful implementation on a quantum simulator with further OQI support in Phase 3 will be made.*
  The addressed problem and its broader societal context are first described, and then linked to an isolated computational problem that is formulated mathematically. An analysis of existing (classical) computational approaches is provided, highlighting their limitations and identifying specific bottlenecks in detail. A quantum computing solution is then proposed that has the potential to overcome these challenges. A comprehensive literature review supports all of these elements. Crucially, the proposal includes a clear and well-founded justification for employing quantum computing in the given context. Subsequently, a proof of concept is outlined, including a robust benchmarking strategy and a detailed resource estimation. Finally, the potential impact of the proposed quantum computing approach is analysed in a broader context.

Use Case Title

Full Proposal

Authors

July 8, 2025

Abstract

Please add a short description of the scope and key objectives of the project. Max 250 words.

Relevant SDGs

Please list the relevant UN SDGs

1 Description of the problem and its societal context

Please describe the societal challenge you are tackling, including who is affected and where the affected population is, why it is critical and what are the risks if no solution emerges (timeline), and what are the current approaches and/or current initiatives from the SDG communities to solving the societal challenge. Please include relevant references.

2 Description of the computational challenges

2.1 Mathematical formulation of the problem

Please describe the mathematical problem associated with the societal challenge in a detailed quantitative formulation with a mathematical model / conceptualisation and identify the key variables. Please include relevant references.

2.2 Classical computational approaches

Please explain how the mathematical problem is solved computationally. Based on state-of-the-art classical computational approaches, this includes specifying what are existing limitations and identifying bottlenecks. Provide references on the literature review of this topic and comment on known initial conditions for the model to be useful.

2.3 Description of the potential quantum computing solution

Please argue in detail for the relevance and the need for quantum computing to solve the problem at hand. Specify which of the identified classical bottlenecks could benefit from a quantum computing approach, what quantum approach you are proposing to do, and why. Where it is possible, use references to justify your decisions, alongside mathematical proofs of scaling advantages or complexity analysis of the classical vs quantum methods. If this problem has been tackled with quantum computing in the past, please explain how the proposed approach differs and include references.

3 Implementation of a proof of concept

A proof of concept can vary in meaning depending on whether the proposed quantum computing solution is feasible on near-term hardware or requires fault-tolerant quantum computers anticipated in the longer term. A proof of concept on near-term hardware might demonstrate that a simplified version of an algorithm can run on current noisy intermediate-scale quantum devices. A proof of concept on anticipated fault-tolerant quantum hardware might explore the scalability or theoretical performance of an algorithm.

If not already clear from the previous section, please make clear what your proof of concept is about. If your proposal includes both a near-term implementation and an anticipated fault-tolerant implementation, please provide the relevant information in the below subsections 3.1-3.4 for both approaches.

3.1 Description of the proof of concept

Please describe your proposed proof of concept to demonstrate the feasibility of the proposed quantum solution. This includes defining the regime of parameters to achieve quantum advantage and the problem size to be tackled (now and/or with future quantum computing devices). Please also specify whether access to real-world datasets has been secured and whether other known necessary initial conditions for the proof of concept are met. As always, include relevant references.

3.2 Benchmarking strategy

As part of the proof of concept, please specify the strategy to benchmark the proposed quantum computing solution against state-of-the-art classical approaches and quantify the expected benefits of the quantum approach. Include relevant references.

3.3 Resource estimation

Using existing resource estimation tools, please assess the resources needed both for the quantum and classical parts of the proposed solution, including but not limited to circuit depth, qubit count, function calls, and run time. This includes specifying what type of quantum computing device would be most suitable and, in the case of a proposed implementation on near-term hardware, which hardware providers would be ideal for the implementation of the

proof of concept. Please also discuss whether it is feasible to first perform small-scale tests on existing quantum simulators and, if so, which would be the ideal simulation providers. Please also comment on the projected energy consumption for both a small-scale implementation during the proof of concept and a full-scale implementation at a later stage.

3.4 Steps to achieve a proof of concept

Please describe the steps to deliver a successful proof of concept, from code writing to optimizing the code to tests on simulators and QPUs, including specifying what is conducted by whom in the team.

4 Impact design

Anticipating a future deployment of the full-scale quantum solution in the real-world, please assess the impact of the proposed solution. An impact framework toolkit will soon be available to guide you through this assessment.

- *At a local level, please assess the impact of your proposed solution on people, planet, and prosperity conducted across short-, medium-, and long-term timeframes. Detail the impacted areas and expected outcomes, documenting all assumptions and supporting references.*
- *At a global level, how transposable is the use case to other contexts? What are other geographies or populations that would benefit from the proposed quantum solution (provide facts and references)? Would the conditions be conducive to a similar proof of concept (e.g. access to data)?*
- *At a macro-level, please assess the interlinkages between SDGs to positively or negatively impact other SDGs (benefits vs risks), including mitigation measures if any?*

5 Methods

Add further details and supplementary material in this section. This section is for lengthy explanations of methods and other details, if applicable. It can be deleted if not needed.

Team Presentation

Team Member (First name, Last name)	Affiliation	Country (of the affiliation)	Relevant domain expertise for the project (i) Quantum computing, ii) SDG domain, iii) Application domain, iv) Classical computation (e.g. AI, ML, chemistry, operation research, fluid dynamics, etc.), v) other)	Short Bio (3-5 sentences)

References

How to add Citations and a References List

This section can be deleted later.

You can upload a `.bib` file containing your BibTeX entries, created with JabRef; or import your Mendeley, CiteULike or Zotero library as a `.bib` file. You can then cite entries from it, like this: [**?**]. Just remember to specify a bibliography style, as well as the filename of the `.bib`.

You can find a video tutorial here to learn more about BibTeX.

Annex 3 - Use Case Journey and Action Plan

Below is a sample of the action plan for each phase of the use case journey. A spreadsheet template will be provided to the use case team.

OQI - Action Plan Template

Use case [add use case title]

Date [add date]

Period [specify period]

			Entity A				*Entity B*				*Entity C*				*Entity D*					
Phase	**Category**	**Action item** These are actions to be achieved to complete each phase of development of a use case with the support of OQI. Within a phase, these actions are not in sequential order and most should be achieved in parallel.	**Contributor**	**Duration (in weeks)**	**Contribution amount (CHF)**	**Contribution type**	**Contributor**	**Duration (in weeks)**	**Contribution amount (CHF)**	**Contribution type**	**Contributor**	**Duration (in weeks)**	**Contribution amount (CHF)**	**Contribution type**	**Contributor**	**Duration (in weeks)**	**Contribution amount (CHF)**	**Contribution type**	**Total duration (in weeks)**	**Total contribution amount (in CHF)**
Phase 0 [start date - end date]	*Admin*	*Review the OQI call for application guidelines*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Admin	*Submit application using the application form*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Phase 1 [start date - end date]	*Admin*	*Schedule, prepare for and participate in bi-weekly meetings for phase 1 with OQI team*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Admin	*Specify needs for additional expertise in the team*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Admin	*Write outline using the OQI template*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Admin	*Consolidate team with additional expertise*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Admin	*Submit outline by [outline submission deadline] (latest)*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Technical	*Conduct extensive literature review*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Technical	*Describe the problem and context from IGO/NGO or SDG organisations' perspective*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Technical	*Describe scientific and computational challenges and current bottleneck of exisiting (classical) approaches*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	Technical	*Explain and justify the expected benefit of quantum computing to solve the computational challenge*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	SDG	*Identify addressed SDGs and key respondents from IGO/NGO or SDG organisations*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
	SDG	*Collaborate with IGO/NGO or SDG experts to target and validate the impact of the tacked problem*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Phase 2 [start date - end date]	Admin	Complete and submit action plan by [phase 2 action plan submission deadline] (latest)																	0	Fr. 0
	Admin	Complete and submit budget by [phase 2 budget submission deadline] (latest)																	0	Fr. 0
	Admin	Schedule, prepare for and participate in bi-weekly meetings for phase 2 with OQI team																	0	Fr. 0
	Admin	Refine action plan and/or budget (if necessary)																	0	Fr. 0
	Admin	Review and sign the OQI Framework Agreement (FA), Project Agreement (PA) and *optional Financial Support Agreement (SA)*																	0	Fr. 0
	Admin	Write full proposal using the OQI template																	0	Fr. 0
	Admin	Submit initial draft for mid-review by [mid-term review submission deadline] (latest)																	0	Fr. 0
	Admin	Submit full proposal for final review by [full proposal submission deadline] (latest)																	0	Fr. 0
	Technical	Address issues raised regarding scientific part in evaluation after phase 1 (if applicable)																	0	Fr. 0
	SDG	Address issues raised regarding impact part in evaluation after phase 1 (if applicable)																	0	Fr. 0
	Technical	Secure access to real-world data (if data-driven approach) or define the initial conditions for a simulation																	0	Fr. 0
	Technical	Describe the mathematical concept with domain experts																	0	Fr. 0
	Technical	Describe best-in-class classical approaches with classical computing domain experts																	0	Fr. 0
	Technical	Describe the classical complexity and identify bottlenecks of classical approaches																	0	Fr. 0
	Technical	Justify the need for a quantum computing approach																	0	Fr. 0
	Technical	Describe the quantum approach, its complexity and justify the choice																	0	Fr. 0
	Technical	Define the methodology for benchmarking the quantum against classical approaches																	0	Fr. 0
	Technical	Define the regime of parameters to achieve quantum advantage																	0	Fr. 0
	Technical	Perform resource estimation of the proposed quantum computing approach, including a justification of its expected scaling																	0	Fr. 0
	Technical	Justify the expected benefit of quantum computing to solve the computational challenge based on the investigations done for the previous items in lines 36 to 40																	0	Fr. 0
	SDG	Collaborate with IGO/NGO or SDG experts to validate the tackled problem																	0	Fr. 0
	SDG	Collaborate with IGO/NGO or SDG experts for impact design of the proposed solution on people, planet, and prosperity across short-, medium-, and long-term timeframes																	0	Fr. 0
	SDG	Collaborate with IGO/NGO or SDG experts to assess the interlinkage between SDGs (benefits vs risks to negatively impact other SDGs)																	0	Fr. 0
	SDG	Collaborate with IGO/NGO to identify impact indicators and to map involved stakeholders																	0	Fr. 0
	Simulation	Identify a quantum computing provider that would be suited for a simulation																	0	Fr. 0
	QPU implementation	Identify a quantum computing provider that would be suited for an implementation on QPU																	0	Fr. 0
	TOTAL AMOUNT	Fr. 0																		0
Phase 3 [start date - end date]	Admin	Schedule, prepare for and participate in bi-weekly meetings for phase 3 with OQI team																	0	Fr. 0
	Technical	Address issues raised regarding scientific part in evaluation after phase 2 (if applicable)																	0	Fr. 0
	SDG	Address issues raised regarding impact part in evaluation after phase 2 (if applicable)																	0	Fr. 0
	Simulation	Develop code and commit code to GitHub																	0	Fr. 0
	Simulation	Collaborate with quantum computing / simulation provider to optimize code and finalize resource estimation																	0	Fr. 0
	Simulation	Map the problem / solution architecture to specific hardware / simulation provider																	0	Fr. 0
	Simulation	Perform small-scale first simulations																	0	Fr. 0
	Simulation	Perform larger-scale simulations, with real-world data (if data-driven approach)																	0	Fr. 0
	Simulation	Perform simulations with and without noise models of your chosen hardware. How does the accuracy / success metric degrade?																	0	Fr. 0
	Simulation	Implement any hyper-parameter tuning (if applicable)																	0	Fr. 0
	Technical	Strategize on steps that can be done before moving to hardware to reduce errors from noise.																	0	Fr. 0
	Technical	Provide data showing the scaling of your problem																	0	Fr. 0
	Technical	Provide results compared to classical benchmarks																	0	Fr. 0
	QPU implementation	From the simulation, re-assess the resources and code improvement needed for a QPU implementation																	0	Fr. 0
	SDG	Further refine the impact design together with IGO/NGO or SDG experts																	0	Fr. 0
	Technical	Write internal report and submit by [internal report submission deadline]																	0	Fr. 0
	Technical	Write external report (open-source) - consider arxiv paper - and submit by [external report submission deadline]																	0	Fr. 0
	TOTAL AMOUNT	Fr. 0																		Fr. 0
Phase 4 15/09/2025 - 01/11/2025	Admin	Schedule, prepare for and attend bi-weekly meetings for phase 4 with OQI team																	0	Fr. 0
	Technical	Address issues raised regarding scientific part in evaluation after phase 3 (if applicable)																	0	Fr. 0
	SDG	Address issues raised regarding impact part in evaluation after phase 3 (if applicable)																	0	Fr. 0
	QPU implementation	Collaborate with quantum computing provider to optimize code and finalize resource estimation																	0	Fr. 0
	QPU implementation	Implement on QPU																	0	Fr. 0
	Admin	Write internal report and submit by [internal report submission deadline]																	0	Fr. 0
	Admin	Write external report (open-source) - consider arxiv paper - and submit by [external report submission deadline]																	0	Fr. 0
	TOTAL AMOUNT	Fr. 0																		Fr. 0