# WARA Quantum Computing

Problem Submission Guide

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# Introduction

This guide is intended for Swedish companies interested in exploring quantum computing through a joint collaborative project with **WACQT Research Arena (WARA) Quantum Computing**. It explains the type of information that WARA needs, and how to structure your submission. Examples of the types of problems that are suitable for quantum computing are also provided to help you assess whether your problem could be a good fit.

The Problem Submission should not be a detailed project plan, but a concise document that allows WARA to assess feasibility and relevance before jointly formulating a project plan. Think of it as a conversation starter.

# Selection process

When WARA receives a Problem Submission, WARA's steering committee evaluates it against the following criteria:

- **Scientific and technical depth:** Does the project contribute to raising competence within the Swedish quantum ecosystem?
- **Benchmarking potential:** Is there a clear classical baseline to compare against?
- **Resource availability:** Is there available expertise (WARA staff) and hardware time?
- **Business value:** The potential for industrial impact.

# Write your problem submission

The **Problem Description** should be 2–4 pages and should address the following points:

- **Business need and use-case:** Give a high-level description of the specific business problem. What is the value of solving this problem?
- **Computational bottleneck:** Identify why current solution methods are insufficient. Where does the limitation lie? (e.g., computational time, insufficient memory, energy consumption).
- **Current state of the art:** Account for the current best *classical* method the company uses or knows of. This is important in order to compare and evaluate potential quantum advantage.
  *Note:* At this stage, you do not need to share proprietary algorithms, internal data, or trade secrets. A general description of the method is sufficient. Detailed

technical information can be shared after an NDA is signed after the project proposal is approved.

- **Resources and commitment:** An indication of the type of domain knowledge and in-kind contribution that your organization can provide.

# Contact and Submission

Submit your project proposal as a **PDF** document to WARA Quantum Computing through our submission page on our website. If you are unsure whether your problem is a good fit or need guidance in finding a suitable use-case, we encourage you to reach out to us at wara-qc@chalmersnextlabs.se

## What happens after submission

Once we receive your proposal, it goes through the following process:

1. The WARA Quantum Computing Steering Committee reviews the submission.
2. If approved, the industry partner signs a Letter of Commitment, declaring its engagement for the Planning phase and its 50/50 in-kind contribution alongside WARA.
3. During the Planning phase, a Project Plan is developed jointly with WARA staff, covering the background, aim, methodology, timeframe, and in-kind contribution for the planned work.
4. A Project Agreement is then signed with the Project Plan attached as an amendment.

# Problems suitable for quantum computing

Quantum is particularly promising for certain problems where the structure of the problem aligns with what quantum computers do well. Below, we list the main categories of problems where quantum computing may be suitable, with concrete examples from different industry sectors.

*Note: Quantum advantage on real-world problems has not yet been demonstrated for any of these categories. The purpose of WARA projects is to rigorously explore the potential and build competence, not to guarantee breakthroughs.*

## Combinatorial optimization

Many industrial problems involve finding the best solution from a vast number of possibilities, where the number of candidate solutions grows exponentially with the problem size. Quantum algorithms like QAOA (Quantum Approximate Optimization Algorithm), QITE (Quantum Imaginary Time Evolution), and quantum annealing are being explored for these types of problems.

## Quantum simulation and chemistry

Simulating quantum mechanical systems such as molecules, materials, chemical reactions, is one of the most natural applications of quantum computing. Classical computers struggle with the exponential growth of the quantum state space, which is precisely what quantum computers represent natively.

## Quantum machine learning

Quantum machine learning explores whether quantum circuits can serve as models that learn patterns in data differently or more efficiently than classical neural networks.

## Sampling and Monte Carlo methods

Quantum algorithms can potentially offer quadratic speedups for Monte Carlo-type sampling problems through amplitude estimation techniques. This is relevant wherever Monte Carlo simulation is used but is computationally expensive.