2023 QUANTUM CITY CHALLENGE

SECTOR:

Energy & Utilities

CHALLENGE TRACK USE CASE:

Smart Charging of Electric Vehicles

ATCO SpaceLab was interested in smart technologies aimed at assisting customers in effectively managing their energy requirements and monitoring usage. In this track, we posed the challenge of optimizing the charging schedule for a large fleet of electric vehicles in a hypothetical future city. The city did not yet know how it would avoid exceeding the electricity supply constraints of the charging hub but knew that it would need to balance the charging hub supply and the EV charging demand, the charging time preferences, and the schedule of each EV owner.

This was an optimization problem closely related to well studied NP-hard optimization problems, and we were interested in exploring whether approximate solutions provided by quantum computing might provide advantages over solutions found via classical approaches.

BACKGROUND:

In late 2023, the Quantum City Challenge was launched at the annual summit, qConnect. Three problem statements were posed, curated by two distinguished organizations, ATCO and Canadian Natural. These statements encompassed electric vehicle charging optimization, bitumen viscosity management, and tailings treatment. Each problem statement had been crafted to tackle real-world challenges, encompassing environmental and financial implications, while also providing an opportunity to explore and harness the potential of quantum technologies.
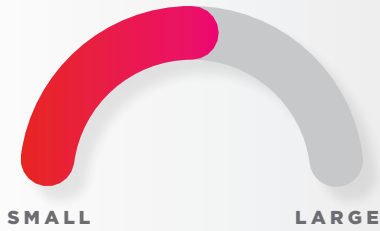
CHALLENGE PROVIDER:

SPACELAB ATCO

WINNER:

AngelQ

SOLUTION IMPACT:

SMALL   LARGE
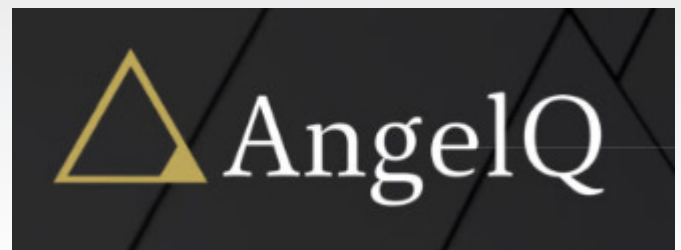
The proposed solution for smart EV charging optimization can enhance energy distribution, especially in managing large fleets. By leveraging quantum algorithms to improve charging schedules, industries could optimize electricity supply, reducing operational costs and increasing efficiency.

TIME TO ADOPT:

NOW   FAULT-TOLERANT
             QUANTUM COMPUTER
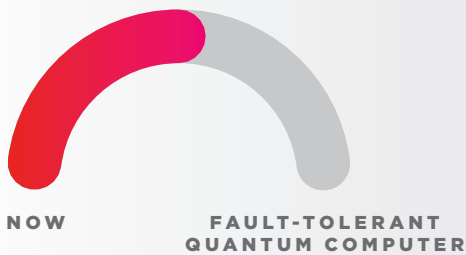
As quantum technology advances, the adoption of quantum algorithms for charging optimization could accelerate rapidly, offering transformative benifits in energy efficiency and cost reduction.

PROPOSED SOLUTION:

The winning submission was from AngelQ, a Singapore-based quantum computing startup. The team adapted a qubit-efficient optimization algorithm to the proposed EV charge scheduling task, demonstrating it was possible to solve reasonably large-scale versions of this problem using limited quantum resources. This result helps to illustrate the ways in which quantum computers can be used to solve hard optimization problems, even in the near term.

FUTURE APPLICATION:

The solution provided by the AngelQ team included a qubit compression method which let them find approximate solutions to optimization problems using dramatically fewer qubits than what would be required by traditional quantum optimization techniques. As the number of qubits available in hardware continues to increase, compression schemes like the one presented by AngelQ may allow us to solve optimization problems which are beyond the reach of classical computers.

 In the context of the original challenge, this would result in a more efficient charging schedule than what we could find classically. Similar techniques could also be applied to other optimization problems: for example in transportation where a more efficient schedule would correspond to less travel time a fossil fuel emissions, or in healthcare where more efficient scheduling could correspond to shorter patient wait times.