Contribution ID: **60** Type: **Poster**

Quantum optimization algorithms in battery adaptive charging

Wednesday, November 29, 2023 5:50 PM (2h 10m)

Quantum Computing (QC) has the potential to revolutionize battery research by not only offering computational advantages over classical computers but aspiring at a potential paradigm shift in computational approaches. Potential research applications of high impact are in material discovery, electrolyte design, reaction kinetics, molecular dynamics, and optimization of charging algorithms.
This work aims at providing an overview of these applications but focuses on optimisation of charging algorithms. Optimization of charging algorithms for batteries is an essential aspect of battery management and energy storage system design. The goal is to maximize the efficiency, performance, and lifespan of batteries while ensuring safe charging operations. Long term scientific progress may arise by simulations of the complex physical and chemical processes, including ion diffusion, electrochemical reactions, and thermal management but also in other domains such as rapid testing of multiple charging algorithms, safety considerations and grid integration. The goal of this research is to introduce an application for QC for adaptive charging where the quantum algorithm could adapt a prohibitively large number of charging parameters in real-time based on the battery's current state. For example, if the battery is showing signs of heating up or increased internal resistance, the algorithm could automatically reduce the charging rate and voltage to prevent overheating and extend the battery's life. Conversely, when the battery is in optimal conditions, it could allow faster charging to meet user demands. The preliminary results point at Quantum Variational Algorithms in specific the Approximate Optimization Algorithm (QAOA) for approximating the solutions to combinatorial optimization problems. Quantum annealers, basic Grover's algorithm, and Quantum Adiabatic optimization are also presented in relation to the problem of adaptive charging.
This work also stresses that QC is still in its early stages, and practical applications are limited by the current state of quantum hardware, which may not yet offer a significant advantage over classical computers for many optimization problems. However, as quantum technology continues to advance, it is expected that quantum optimization algorithms will find broader application in energy research. In order to illustrate the complexity of such developments, this work also presents the overview of a state-of-the-art atomic system.

Primary author: KOUROUSIAS, Georgios (Elettra Sincrotrone Trieste)

Session Classification: Happy Hour and Poster Session