International Conference on Quantum Energy 2025 hosted by Dipartimento di Fisica e Astronomia Galileo Galilei an event by ICQE

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A full-stack assessment of fault-tolerant quantum computing energetics challenges

Wednesday 4 June 2025 14:00 (30 minutes)

Adopting a long-term view, the presentation shows how recent scientific progress in scaling quantum computing is bringing new solutions and new questions on the energetics of these systems, particularly when considering fault-tolerant quantum computing roadmaps.

It starts with refining the definition of an energetic quantum advantage, laying out the interconnection between the economics of quantum computing and its viable applications, which impacts the notion of energy consumption acceptability. It shows how utility-grade algorithms resource and time estimates bring new questions on the energetic and power costs of quantum computing, highlighting the contrast between theoretical and practical quantum advantages.

It then identifies key emerging scalability challenges and their related potential energetic costs and constraints like quantum processors scaling limits, qubit non-local connectivity and quantum error correction overhead, qubit gate and readout times and the new critical role of quantum processor interconnect. It shows how systems architecture design strongly influences the energetic footprint of FTQC quantum computers.

The overarching role of the presentation is to propose new research questions and avenues connecting quantum science and engineering with the Quantum Energy Initiative goals.

Theme

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Track Classification: Theme 1. Energy advantage and cost of quantum technology