WORLD QUANTUM CANNES FESTIVAL
ACCELERATING BUSINESS IMPACT

what could determine the energetic footprint of fault-tolerant quantum computers?

#QEI
the quantum energy initiative

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WQCF, Cannes, November 17th, 2026

#QEI

the quantum energy initiative

quantum-energy-initiative.org/





QEI 2025 (Grenoble) and 2026 (Barcelona)

why

- ICT energy consumption is growing fast.
- most quantum technologies will add an incremental energetic cost to existing ICT.
- it is time to work on this as quantum technologies and applications are designed.
- responsible innovation imperative.

what

- build a **new** science and engineering field.
- create full-stack methodologies and standards to **evaluate**, **optimize**, and **benchmark** quantum technologies energy consumption.
- favor integrative **full-stack approaches**.

how

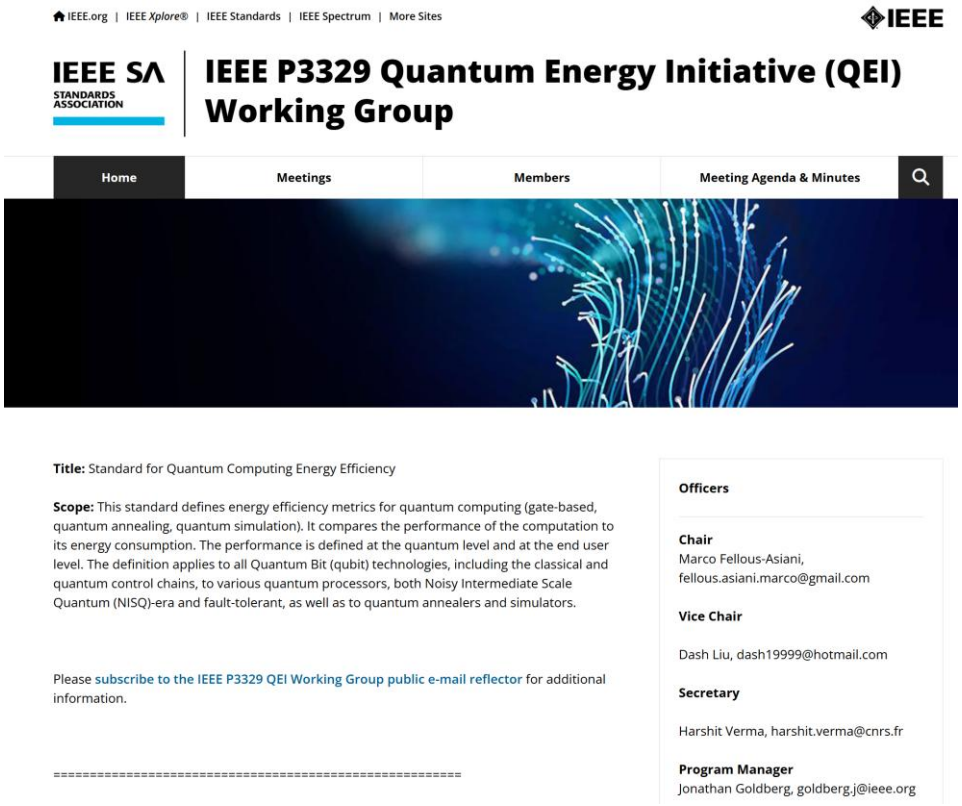
- QEI scientific board (10).
- QEI community (545 participants from 67 countries) *.
- QEI workshops (2023 in Singapore, 2025 in Grenoble, 2026 in Barcelona, 2027 in Lisbon).
- QEI IEEE standards Workgroup.
- ≈30 industry partners including IBM, Quandela, etc.

* : as of September 28th, 2026

IEEE QEI Workgroup role

https://sagroups.ieee.org/qei/

define how you evaluate the energy consumption of a quantum computing system



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IEEE

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IEEE P3329 Quantum Energy Initiative (QEI) Working Group

Home | Meetings | Members | Meeting Agenda & Minutes

Title: Standard for Quantum Computing Energy Efficiency

Scope: This standard defines energy efficiency metrics for quantum computing (gate-based, quantum annealing, quantum simulation). It compares the performance of the computation to its energy consumption. The performance is defined at the quantum level and at the end user level. The definition applies to all Quantum Bit (qubit) technologies, including the classical and quantum control chains, to various quantum processors, both Noisy Intermediate Scale Quantum (NISQ)-era and fault-tolerant, as well as to quantum annealers and simulators.

Please subscribe to the IEEE P3329 QEI Working Group public e-mail reflector for additional information.

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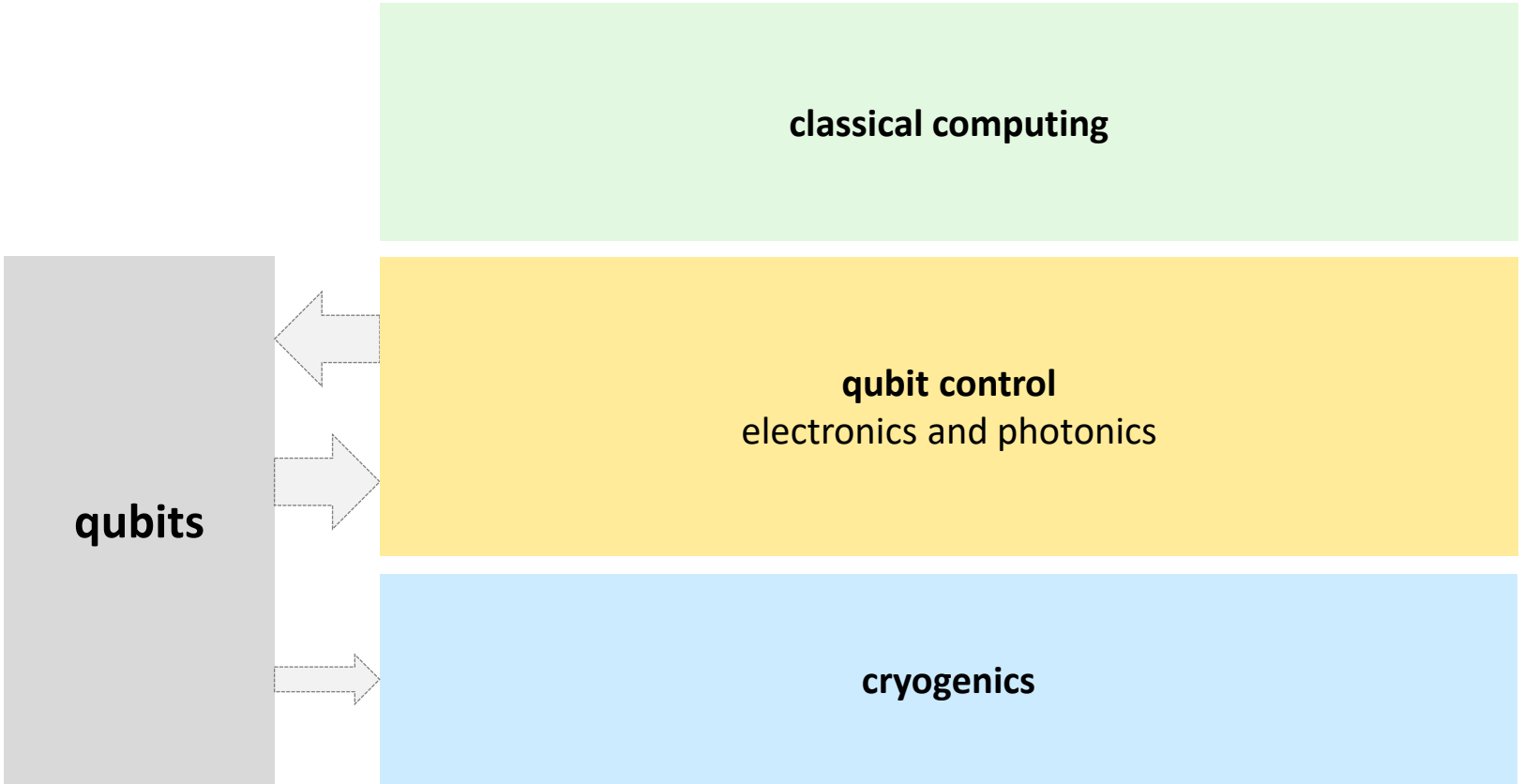
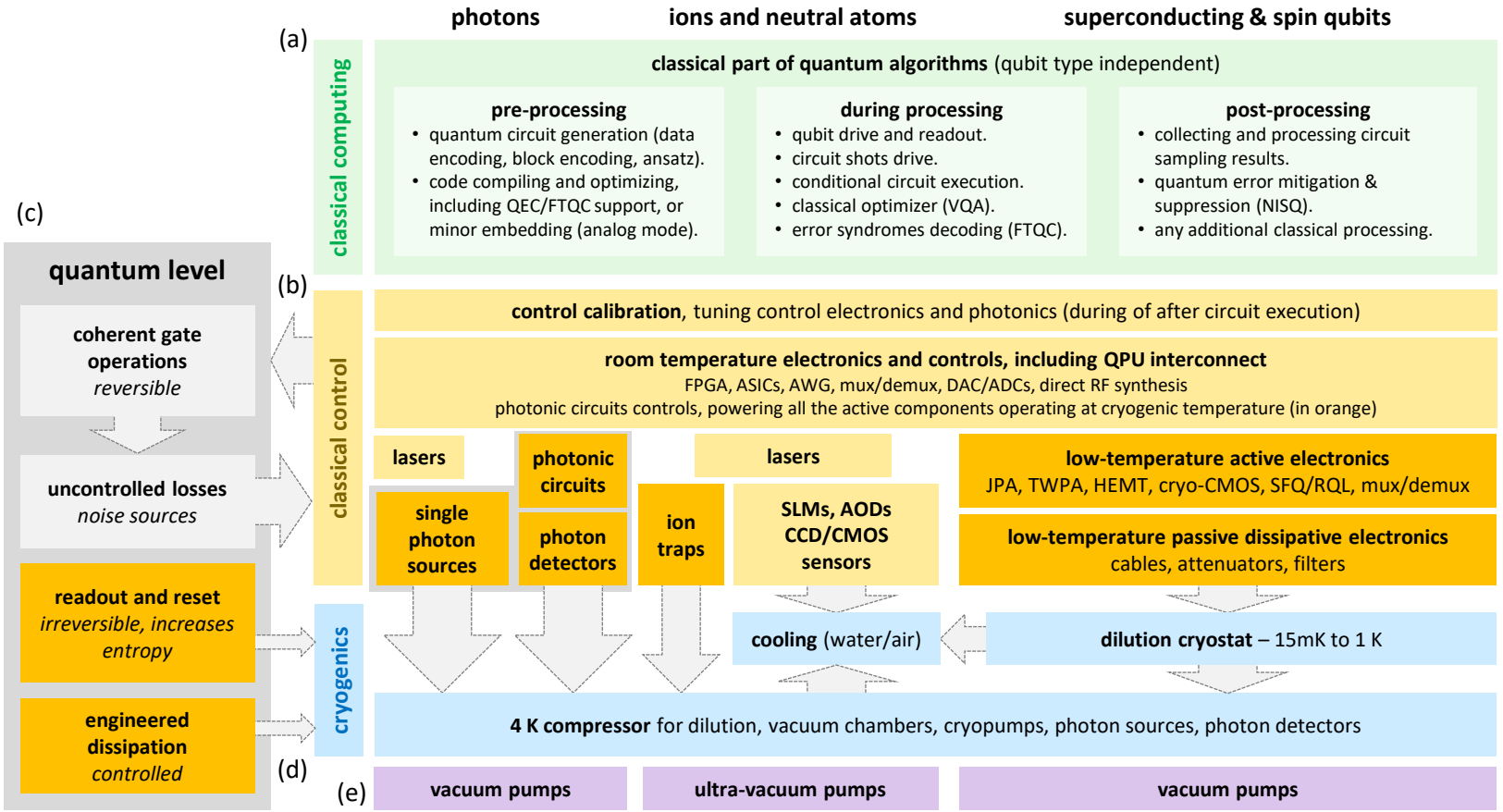
energy consumption sources



source: Olivier Ezratty, October 2026

quantum ↔ macroscopic costs



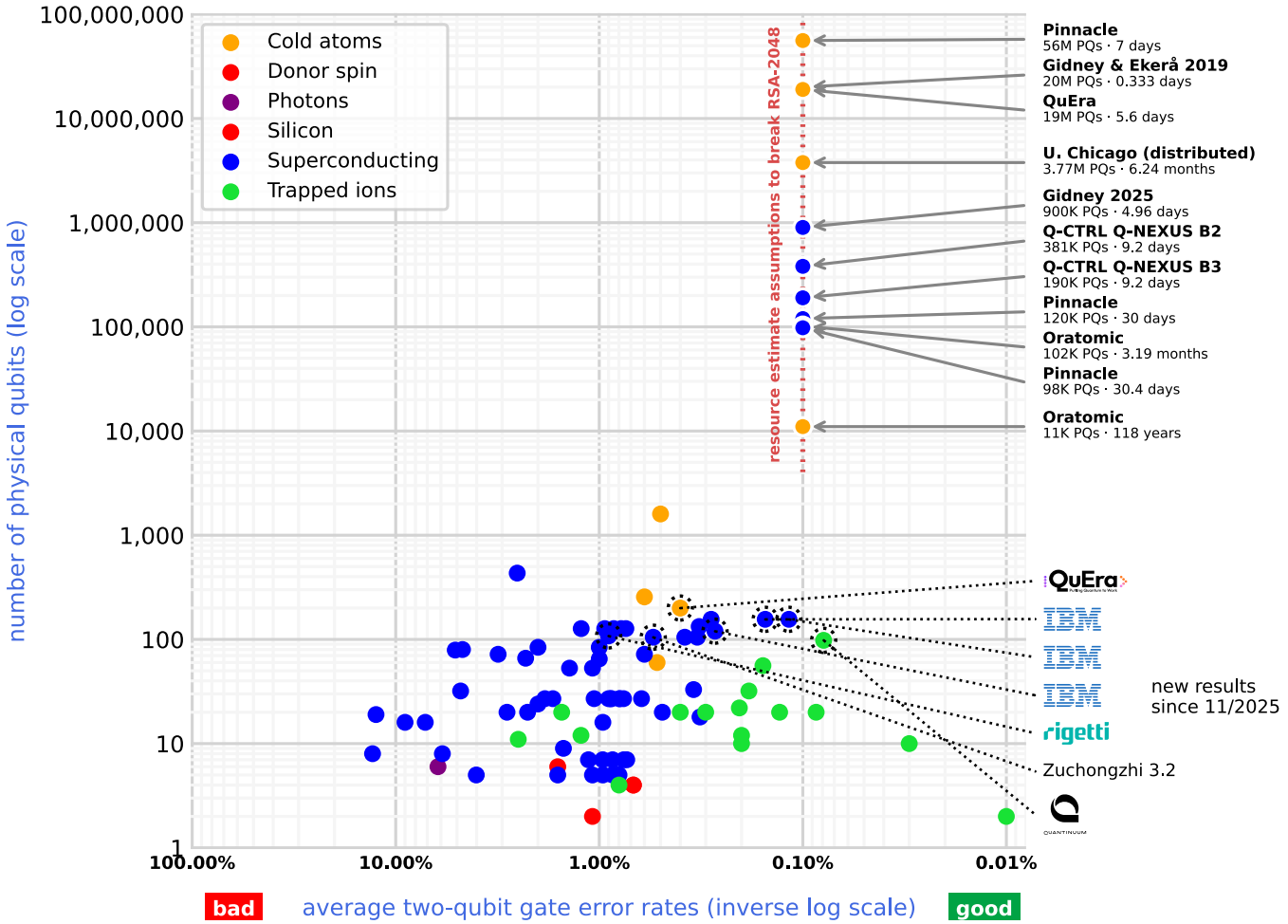
source: Understanding Quantum Technologies 2026, Olivier Ezratty, September 2026

physical error rate assumptions in QEC/FTQC resource estimates:

- 99.9% reset fidelity
- 99.9% single qubit gate fidelity
- **99.9% two qubit gate fidelity**
- 99.9% idle state fidelity
- **99.9% readout fidelity**
- usually, missing correlated noise sources + unknown noise sources at scale + space-time variability + calibration costs.

=>

- quantum energetics.
- material sciences.
- high-quality manufacturing.
- high-quality qubit control.
- QPU interconnect overhead.



looming energetic challenge

New Scientist

Technology

Some quantum computers might need more power than supercomputers

A preliminary analysis suggests that industrially useful quantum computers designs come with a broad spectrum of energy footprints, including some larger than the most powerful existing supercomputers

By Karmela Padavic-Callaghan

8 January 2026

https://www.newscientist.com/article/2509492-some-quantum-computers-might-need-more-power-than-supercomputers/

PT PHYSICS TODAY

NEWS / ARTICLE

How much electricity does a quantum computer need?

JUN 15, 2026

The question is attracting attention amid rising energy use by classical computing data centers.

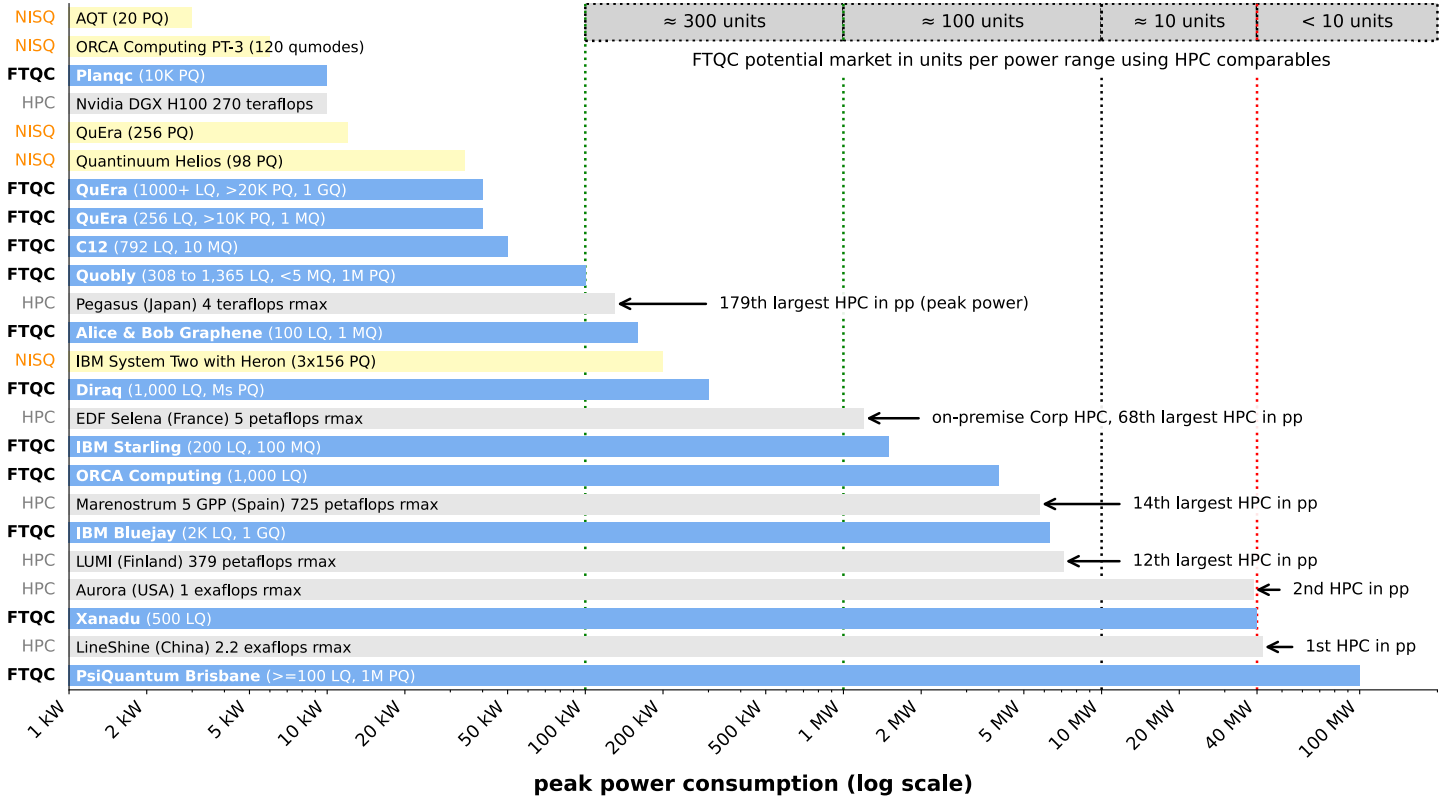
DOI: 10.1063/pt.41fbb5d95c

Jenessa Duncombe

https://physicstoday.aip.org/news/how-much-electricity-does-a-quantum-computer-need



NISQ-FTQC-HPC power comparables



estimate base power for various FTQCs and actual for existing largest HPCs WW and NISQ QCs. HPC source: TOP 500 and Nvidia. FTQC sources: vendor data or data reconciliation.
PQ: physical qubits
LQ: logical qubits.
MQ: megaquop (logical operations).
TQ: teraquop.

power comparable warnings

1. **vendor numbers give some indication of the potential power/energy needs for future FTQC systems.**
2. **the distribution and comparison with HPC systems gives an indirect indication of a potential market size.**
3. **numbers are based on multiple optimistic assumptions:**
   - optimistic physical error rates: 99.9% for all operations.
   - incomplete error models: leakage, losses, correlated errors at scale, variability.
   - not accounting for the overhead of quantum interconnect.
   - enabling technologies efficiencies: cryogenics, electronics, photon losses.
4. **they do not account for the speed difference between systems.**
   - these differences play a key role when comparing the energy consumption and computing times for specific quantum computing workloads.

counter intuitive insights



cryogenics

- all qubit types rely on cryogenics.
- it's usually a variable cost vs physical qubit #.
- cryogenics may not be the dominant energetic cost for many qubit modalities.

science vs engineering

- still room for progress at the fundamental level.
- enabling technologies key role.
- many interdependencies and potential counterintuitive optimizations.



electronics and photonics

- control electronics and photonics may become the dominant energetic cost in solid state platforms.

classical computing

- classical energetic costs must be considered before, during and after a quantum circuit run.
- compilation is a variable cost vs the problem data.



error correction

- error syndrome detection may dominate energetic costs for some qubit modalities.

economics

- energy could represent >30% of an FTQC TCO.
- energy = power (infra) × time (user constraints).
- power is a proxy for all environmental footprint.

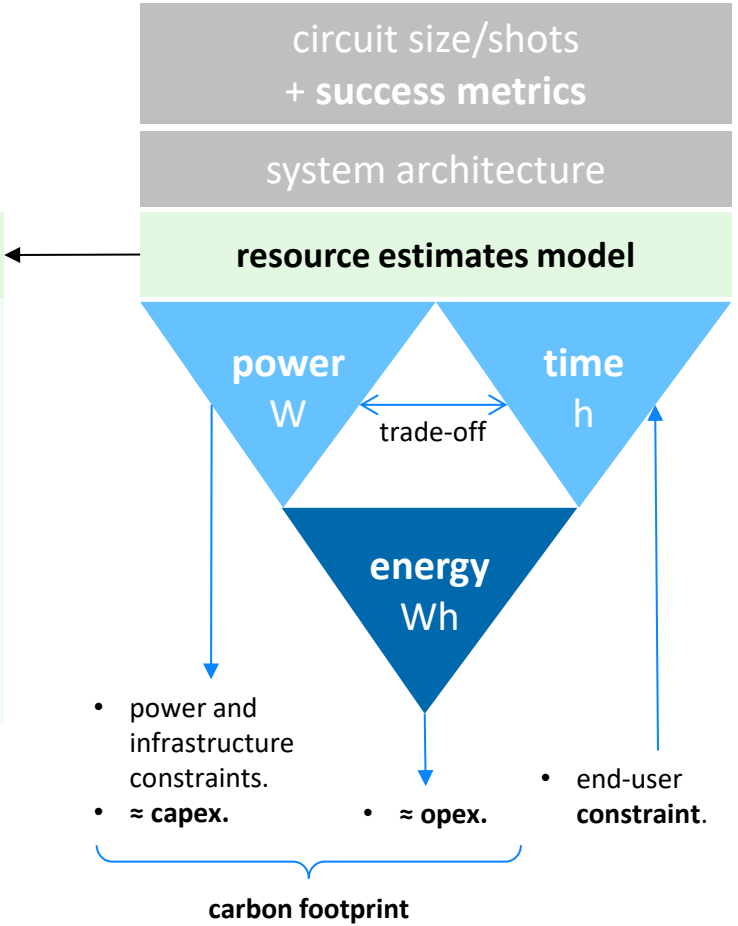
optimization options

holistic optimizations

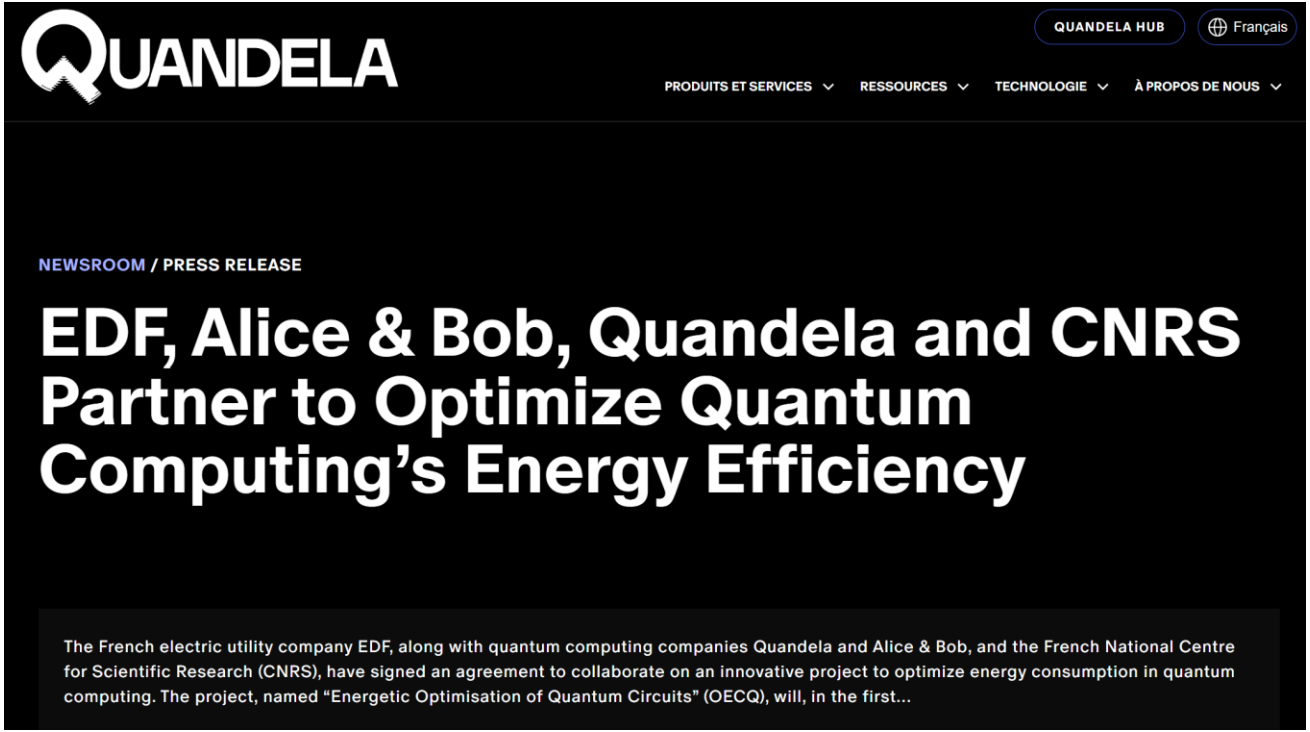
reductionist optimizations

- optimize the consumption of individual components in the stack, without introducing more noise on the processor.
- key for enabling technologies.

- interdependent optimizations.
- typically, can involve trade-offs between spending less energy and introducing more noise.
- can be highly counter-intuitive.
- requires a full-stack approach and modelling.



interdisciplinarity needs



An official website of the European Union How do you know?

European Innovation Council

Quantum Energetics

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Expected Outcomes and Impacts
Portfolio approach and activities
EIC Work Programme 2027
How to apply

Background and scope

Quantum technologies hold the promise of transforming various sectors by, for example, delivering step changes in data processing capabilities, enhancing the security of communication, and through higher sensing capabilities. This promise has attracted significant public and private investments across the globe. However, large scale deployment may come with a significant energy and environmental footprint. Energy efficient quantum technology will bring a competitive advantage, and to develop this, key questions are how energy consumption scales with system size; what is the dependence on performance and the underlying technology; how does it compare to classical counterparts.

In full-stack quantum computers including qubits, error correction, control electronics, cooling systems, and supporting infrastructure energy usage differs fundamentally from current systems. For example, in superconducting systems, most of the energy is spent on maintaining the operating environment and not on the computation itself; the balance differs markedly across platforms. Superconducting quantum computers must operate at temperatures close to absolute zero. Their cooling systems, known as dilution refrigerators,

discussion



get the slides, now!