Quantum computers might one day be able to factor huge numbers or search vast databases, but when it comes to word-processing or accessing the internet, forget it. That is the conclusion of two US physicists, who have calculated the energy efficiency of a quantum computer and compared it with that of a traditional, classical machine. Julio Gea-Banacloche of the University of Arkansas and Laszlo Kish of Texas A&M University say that classical computers are far better at carrying out general-purpose tasks (Fluctuation and Noise Letters 3 C5).

Still at the very early stages of development, quantum computers rely on the properties of quantum mechanics to perform large numbers of calculations in parallel. They exploit the ability of a quantum particle to be in two states at the same time, such as the spin of a nucleus pointing simultaneously up and down relative to an applied electric or magnetic field. With the two states representing a one and a zero, such particles — referred to as qubits — can then be combined or "entangled" so that they represent two values simultaneously. A quantum computer would, in principle, be able to process each of these values at the same time, making it exponentially faster than a classical computer.

However, Gea-Banacloche and Kish argue that this speed would come at a price for many applications. They compared the minimum energy needed to perform an error-free logical operation on both a quantum computer and a classical machine. They calculated that the error — caused by quantum fluctuations — involved in switching a qubit is inversely proportional to the energy used in the switching. But they found that the error in the classical case — arising from thermal noise — decreases exponentially with increasing switching energy. They therefore concluded that to operate below a certain error rate, a classical computer requires less energy than a quantum device.

"It is sometimes suggested, especially in the popular press, that quantum computers might be the natural successors to today’s conventional digital computers, as the current trends in miniaturization reach the atomic level," says Gea-Banacloche and Kish. "While it is true that there are a few special tasks that a quantum computer could perform much faster than a classical computer, such as factoring integers, it may not make sense to push conventional computers into the quantum domain for anything other than these very special purpose tasks."