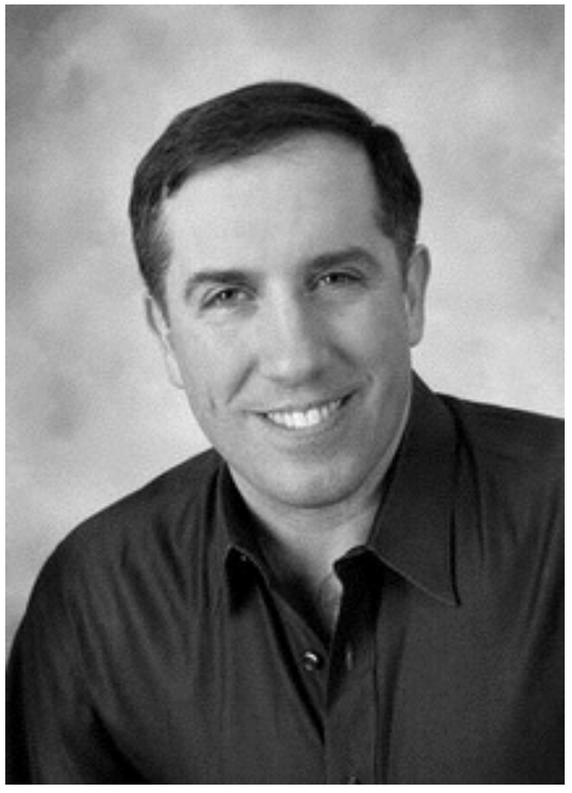
Carnot

Betz

Moore



Koomey

Landauer

Malthus

Jevons

Lovins

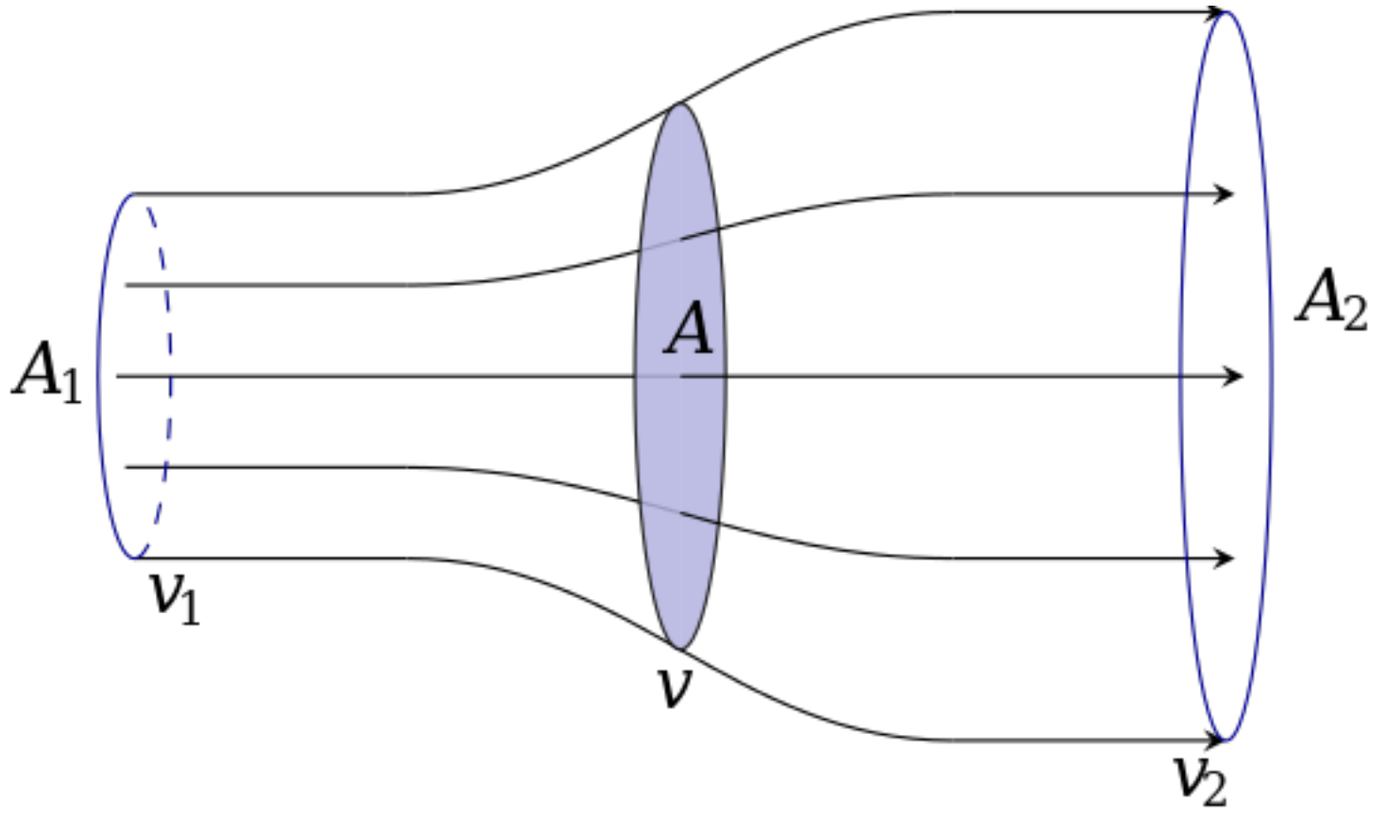
# Carnot's Theorem

$$\eta_{\max} = \eta_{\text{Carnot}} = 1 - \frac{T_{\text{C}}}{T_{\text{H}}}$$

where ***TC is the absolute temperature of the cold reservoir***, TH is the absolute temperature of the hot reservoir, and the efficiency (*Eta)* is the ratio of the work done by the engine to the heat drawn out of the hot reservoir.

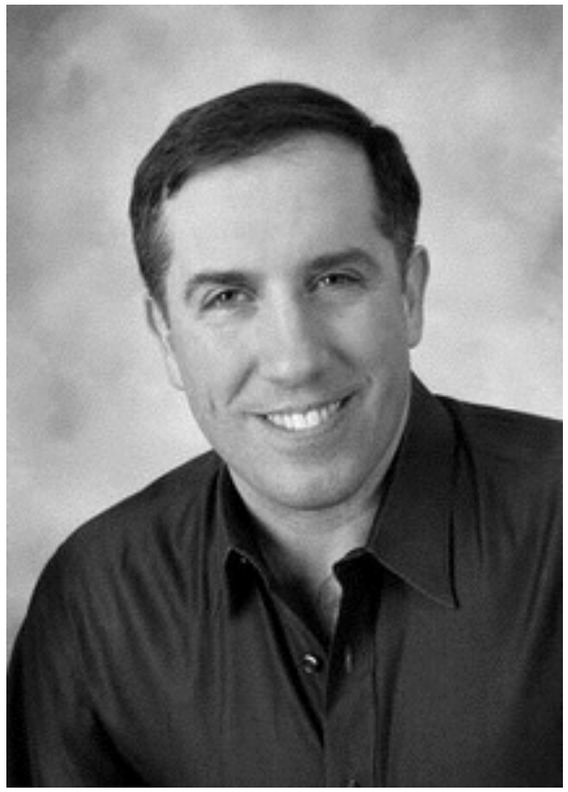
*-Wikipedia*

# Betz Limit




Betz's law indicates the maximum power that can be extracted from the wind, independent of the design of a wind turbine in open flow… According to Betz's law, no turbine can capture more than 16/27 (59.3%) of the kinetic energy in wind.

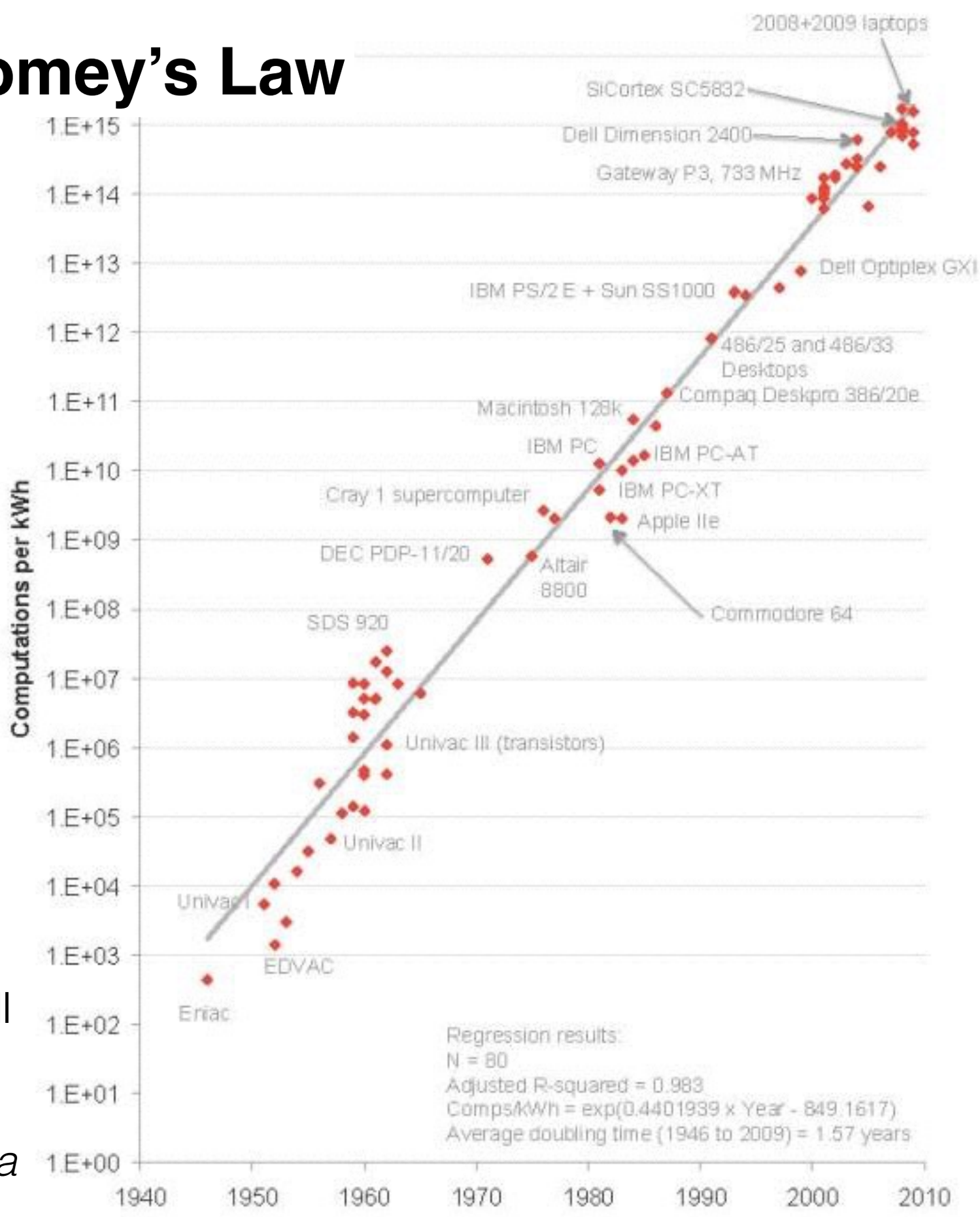
*-Wikipedia*



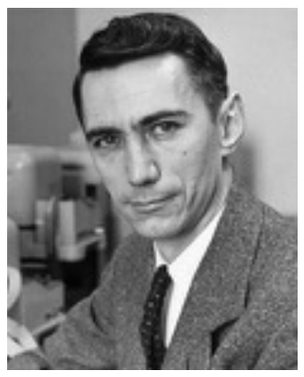
# Koomey's Law

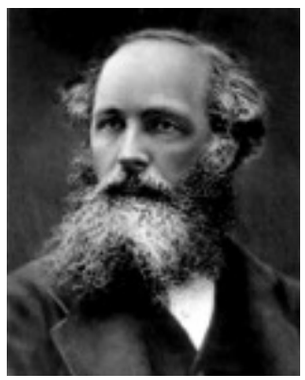
The number of computations per joule of energy dissipated has been doubling approximately every 1.57 years…somewhat faster than Moore's law. Koomey: "at a fixed computing load, the amount of battery you need will fall by a factor of two every year and a half."

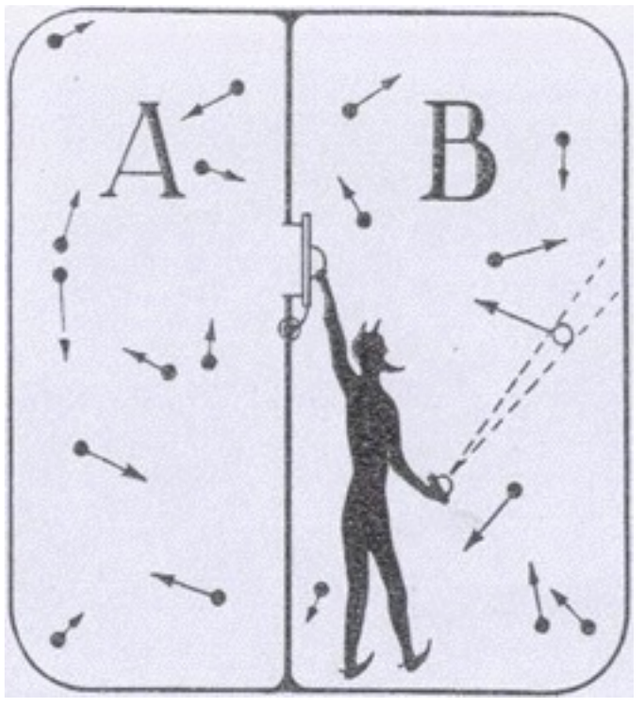
*-Wikipedia*



# Landauer’s Limit








Landauer's principle… holds that "any logically irreversible manipulation of information, such as the erasure of a bit or the merging of two computation paths, must be accompanied by a corresponding entropy increase in non-information-bearing degrees of freedom of the information-processing apparatus or its environment”… [put another way] **if an observer loses information about a physical system, the observer loses the ability to extract work from that system**…In 2016 researchers used a laser probe to measure the amount of energy dissipation that resulted when a nanomagnetic bit flipped from off to on. Flipping the bit required 15 millielectron volts (3 zeptojoules).

*-Wikipedia*



# Malthusian Spectre
# Jevons' Paradox
# Lovins - ?

When the efficiency of something increases - food production, manufacturing, energy efficiency of a service, etc. - do we do
A) the same with less?
B) more with the same? *or*
C) way more with some more?