I really do encourage other manufacturers to bring electric cars to market. It's a good thing, and they need to bring it to market and keep iterating and improving and make better and better electric cars, and that's what going to result in humanity achieving a sustainable transport future. I wish it was growing faster than it is.

Arizona State University
SES 194

Energy in Everyday Life

Order of Magnitude Estimate

Frank Timmes

ftimmes@asu.edu

How much energy is in a gallon of gas?

Our guidelines for making an order-of-magnitude estimate:

* *Guess*
* *Talk to your gut*
* *Divide and conquer*
* *Lie skillfully*
* *Punt*
* *Use guerrilla warfare*
* *Lower your standards*
* *Cross-check*

GUESS

I know one human heartbeat is about 1 joule.

Maybe a gallon of gas is worth a million heartbeats, so I'll guess 10^6 J in one gallon of gas.

Common Knowledge

Share what you know.

My car gets ~ 30 miles/gal @ 60 mph on the highway.

At 60 miles/hr on the highway, I will be able to drive for 30 min = 30 min × 60 sec/min ~ 2000 sec on one gallon of gas

Convert my speed from miles/hr to m/sec:
60 miles/hr ~ 60 miles/hr × 1.6 km/mile ~ 100 km/hr.
100 km/hr ~ 100 km/hr × 1000 m/km × 1 hour/3600 s ~ 25 m/s

I estimate my car (Cooper Mini) weighs ~2500 lbs, which is ~ 2500 lb × 0.45 kg/lb ~ 1000 kg.

**I now have a time (~2000 s),
a speed (~25 m/s),
and a mass (~1000 kg).**

My car's energy of motion (kinetic energy) is then

$1/2 \times \text{mass} \times \text{speed}^2 \sim 1/2 \times 1000 \times (25)^2 \sim 10^5$ J.

The power my car consumes to maintain this energy of motion for one second is

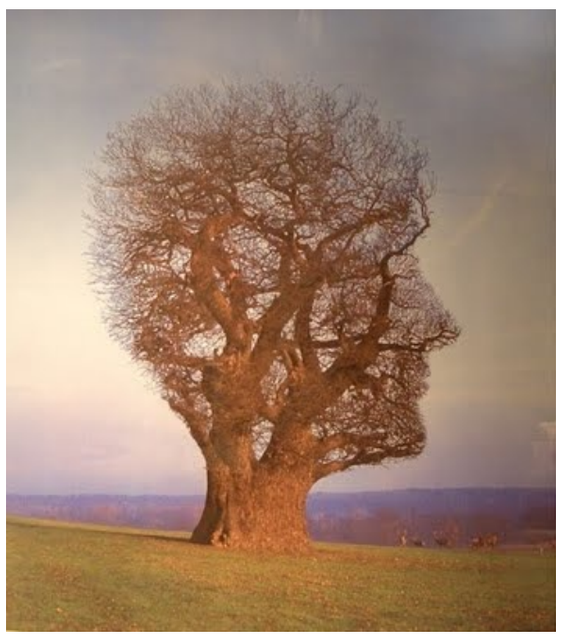
power = energy / time = 10^5 J / 1 sec = 10^5 W.

Since I can drive my car for 2000 sec,
the total energy my car consumes and
the energy in one gallon of gas is about

energy = power × time = 10^5 W × 2000 sec ~ 2×10^8 J

This is a 100 times more than my initial guess of 10^6 J.
Not great, but ok.

Call me a geek, but I happen to know that the energy density of common chemical fuels is typically tens of megajoules per kilogram.



I also know from my bicycle adventures that a gallon of H_2O weighs 8 lbs. I'll assume gas and water weigh the same.

So, the energy in one gallon of gasoline is about

energy ~ 20 x 10^6 J / kg × 8 lbs × 0.45 kg/lb ~ 8 x 10^7 J.

This is close to my car driving estimate of ~ 2 × 10^8 J

So my final estimate is ~ 10^8 J in one gallon of gas.

Energy: 110 Orders of Magnitude